Rai Chunilal Bose Bahadur, C.I.E., I.S.O., M.B., F.C.S.,
Rasayanachariyia.

THE SCIENTIFIC

AND

OTHER PAPERS

OF

RAI CHUNILAL BOSE BAHADUR, C.I.E.
I.S.O., M.B., F.C.S., *Rasayanachariyia.*

VOL I.

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DEDICATED

WITH REVERENT LOVE

TO THE MEMORY OF MY UNCLE

RAI SAHIB AMRITA LAL BOSE

A brief record of the life and career

of

RAI CHUNILAL BOSE BAHADUR, C.I.E., I.S.O., M.B., F.C.S.,
Rasayanachariyia.

Early Life.

Dr. Chunilal Bose was born at Calcutta on the 13th March, 1861. He is the second son of the late Babu Denonath Bose of Shambazar and belongs to a *Kayastha** family which settled in Calcutta in the early part of the 19th century. His ancestral home is at Changripota, a village near Harinavi in the district of 24 Parganas.

Dr. Bose received his early education in a local Upper Primary School (now the Shambazar Anglo-Vernacular School) which has recently been affiliated to the Calcutta University up to the Matriculation standard and of which he is now the President. He received his first English education in a school located in the same building and which was afterwards called the Northbrook School. He was for some time a student of the Metropolitan Institution (Shampuker branch) founded by the late illustrious Pandit Iswara Chandra Vidyasagara. He passed the Entrance Examination of the Calcutta

University in 1877 from the Sanskrit Collegiate School and after passing the First Examination in Arts from the General Assembly's Institution (now the Scotitsh Churches College), joined the Calcutta Medical College in 1880. His father at that time was not in easy circumstances and the family had hardly means enough to give him a medical education. Dr. Bose had to make strenous efforts for prosecuting his studies and to suffer many hardships and privations. He, however, worked hard and conscientiously and was regarded as a promising student by his professors in the Medical College. He obtained gold medals in Botany, Pathology and Medicine and Certificates of Honour and Prizes in Anatomy, Surgery, Midwifery, Medical Jurisprudence, Hygiene, Clinical Medicine and Clinical Surgery. He passed both the First and the Final M.B. Examinations in the first division.

Official Career.

Dr. Bose joined Government service as an Assistant Surgeon in March 1886. He was appointed in 1887 as the Assistant Chemical Examiner to the Government of Bengal and Assistant Professor of Chemistry, Medical College, Calcutta, under the late Surgeon-Major C. J. H. Warden, M.D., I.M.S., but immediately afterwards was sent to Upper Burma in charge of the Civil Hospital at Taungdwingi (now Magwe). In 1888, he rejoined his permanent appointment in the

Chemical Laboratory of the Medical College, Calcutta, and in 1894 was appointed Additional Chemical Examiner in succession to the late Rai Tara Prosanna Roy Bahadur. He remained in charge of the Medico-legal Section of the Department until April, 1915. Bewteen 1889 and 1913, he was appointed on several occasions to officiate as Chemical Examiner to Government and Professor of Chemistry, Medical College, Calcutta.

Dr. Bose relieved Lt.-Col. F. N. Windsor, I.M.S., (called to military duty) on the 28th April, 1915, and acted continuously as Chemical Examiner to the Government of Bengal and Professor of Chemistry, Medical College, Calcutta, upto 12th March, 1920, when he took six months' privilege leave preparatory to retirement. During this period, he was a member of the College Council of the Calcutta Medical College. The Council met on the 18th March, 1920, and passed the following appreciative resolution acknowledging his valuable services to the College :—

"*The Council desire to place on record their regret at the retirement from Government service of Rai Chunilal Bose Bahadur, I.S.O., M.B., F.C.S., who has, for many years been connected with the College as a teacher, was for six years Professor of Chemistry and also a member of the Council of the Medical College. During all these years, this officer has been untiring in his*

devotion to everything pertaining to the highest interests of the College and the welfare of the students. The Council trust that he may long be spared to enjoy his well-earned retirement."

The Council has placed a portrait of Dr. Bose in the Professors' Room of the Calcutta Medical College.

On the day of his retirement, the staff of the Chemical Examiner's Department met at the laboratory under the presidency of Major R. B. Lloyd, I.M.S. (Dr. Bose's successor) to bid him farewell. They presented him with a silver tea cup bearing a suitable inscription giving expression to their affection, regard and esteem for him.

In reviewing the annual report of the Chemical Examiner's Department for the year 1919, the Government was pleased to record its appreciation of the long services of Rai Chunilal Bose Bahadur in the following terms :—

"This is the last report that will be issued by Rai Chunilal Bose Bahadur, I.S.O., M.B., F.C.S., as this valued officer is now proceeding on leave pending retirement. Rai Chunilal Bose Bahadur has served for nearly 34 years in the Chemical Examiner's Department and during his ardous life, has acted as Chemical Examiner and Professor of Chemistry on no less than 13 occasions, and has continuously held this high

important post for almost 6 years. With the Rai Bahadur's retirement, Government loses the service of one of the ablest and most popular officers serving under the Medical Department, a highly scientific chemist, a popular teacher and a man of many talents blessed with a spirit of intense application. No officer could have rendered Government more faithful and loyal service."

Dr. Bose retired on the 12th September, 1920, after serving the Government for 34 years 5 months and 13 days. In the Triennial Report of the Medical Department of the Government of Bengal for 1920, 1921 and 1922, in noting the retirement of Officers during that period, a very appreciative reference has been made in regard to the long and valuable services of Dr. Bose.

Dr. Bose was elected a Vice-President of the First Indian Medical Congress in the Medico-legal Section held in Calcutta in 1894, and as such, read a joint paper with the late Capt. J. F. Evans, I.M.S., on "The *Necessity for an Act to restrict the Free Sale of Poisons in Bengal,*" which was submitted to the Government of India by the Council of the Medical Congress and which subsequently led to the passing of the Poison Act of 1904.

Public Activities.

He was elected a Fellow of the Chemical Society, London, in 1894, and a Fellow of the

Calcutta University in 1898 and since then, has been a member of the Faculties of Science and Medicine and of the Boards of Studies in Medicine, Chemistry, Physiology, Zoology, and Botany and has been acting as an Examiner in Arts, Science and Medicine. He is also a member of the Council of Post-Graduate Teaching in Science and of its Executive Committee. He was appointed Teacher of Chemistry and Physics in the Campbell Medical School, Calcutta, in 1896. He has been lecturing in Chemistry at the Indian Association for the Cultivation of Science since 1899. He was for three years the Editor of the Calcutta Medical Journal, the organ of the Calcutta Medical Club of which he was a Vice-President for a few years. He is one of the Vice-Presidents of the *Bangiya Sahitya Parishad* and was Secretary of the *Sahitya Sabha* and of the Sobhabazar Benevolent Society for many years. He is one of the Vice-Presidents of the District Charitable Society of Calcutta and is the President of its Indian Committee. He is one of the Secretaries of the Calcutta Orphanage and of the Calcutta Blind School, and is one of the Vice-Presidents of the Calcutta Temperance Federation. He is a Vice-President of the Indian Provincial Medical Services Association and was the President of its Bengal Branch for some time. He was for many years a member of the Central Text-Book Committee, Bengal, and of the Indigenous Drugs Committee. He

is a member of the *Conciliation Panel* constituted by the Government to deal with labour disputes affecting public utility services and is also a member of the Sanitary Board and of the Advisory Board of Industries, Bengal. He is a member of the Governing body of the Bethune College and of the Managing Committees of the Bethune Collegiate School and the Sanskrit Collegiate School, Calcutta. He is a Vice-President and Trustee of the Indian Association for the Cultivation of Science and a Vice-President of the Bengal Social Service League.

In 1898, Dr. Bose started the Commercial Analysis Class in the Indian Association for the Cultivation of Science for the benefit of students who desire to be trained in the analysis of water, foods, drugs, ores, and other commercial articles.

He has been connected with the Carmichael Medical College, Belgachia, first as a teacher in its school stage, then as a member of the Executive Committee and lastly as a Life-Member of the Institution. He is associated with various other educational, social and philanthropic institutions in Bengal and outside the province.

Dr. Bose was one of the secretaries of the Chemical Section of the Calcutta Exhibition, 1923. He is the Chairman of the Board of Directors of the Bengal Chemical and Pharmaceutical Works Ltd., and is a Director of the

Calcutta Chemical Co., Ltd., and of the Calcutta Soap Works, Ltd.

In 1896, Dr. Bose submitted a note to the Government of Bengal recommending the use of a *Saturated Solution of Common Salt* as a preservative of cattle-viscera, and of human viscera in cases of alcoholic poisoning. The recommendation was accepted by Government and a *saturated solution* of common salt has since been in use as a preservative of viscera in the above-mentioned cases in the provinces of Bengal, Bihar and Orissa and in Assam.

Contributions to Science & Literature

In 1901, he submitted a thesis on "*The Chemistry and Toxicology of Nerium Odorum*" to the University of Calcutta for which he was awarded the Coates' Memorial Prize.

In 1917, Dr. Bose was elected President of the All India Temperance Conference held in Calcutta and his presidential address has been published in the proceedings of the Conference for that year.

He presided over the Science Section of the Bengal Literary Conference held at Midnapur in 1922 and his presidential address is to be found in the printed proceedings of the Conference for that year.

Dr. Bose delivered a lecture in connection with the first Science Convention held in Cal-

cutta in 1917 on "*Some Practical Hints to improve the Dietary of the Bengalis*", which was published in the proceedings of the Convention. At the second sitting of the Convention in 1919, he read two papers, one on "*The Science Association and its Founder*", and the other on "*Some Common Food-stuffs*"; these have been published in the report of the Convention. He gave a public lecture on the "*Choice of Food*" at the sitting of the Seventh Indian Science Congress at Nagpur in January 1920, and two popular lectures on "*Food*" at the second Industrial and Social Exhibition held at Dacca in March, 1920. He gave a series of popular lectures on *Water, Air, Food* etc. at the *Sahitya Sabha* and the *Bangyia Sahitya Parishad* and also courses of lectures on various chemical subjects allied to Industry and Hygiene at the Indian Association for the Cultivation of Science. Dr. Bose delivered a lecture on "*Impure Air and Infant Mortality*" under the auspices of the Health and Child-Welfare Exhibition held at the Town Hall, Calcutta, in April 1920.

Dr. Bose rendered valuable help to Sir Leonard Rogers in his investigation in Leprosy by preparing for him suitable soluble salts of Gynocardic acid for injection.

Among the papers, original and otherwise, contributed by Dr. Bose singly or jointly to various scientific, medical and literary journals, the more important ones in English are publish-

ed in the two volumes of this book. Dr. Bose has written among others the following books and pamphlets :—

(1) *Falita Rasayana* (Practical Chemistry in Bengali) ; (2) *Rasayana-Sutra* (Elements of Chemistry and Physics in Bengali) ; (3) *Jal* (Water) in Bengali ; (4) *Bayoo* (Air) in Bengali ; (5) *Khadya* (Food) in Bengali ; (6) *Sarira Swasthya-bidhan* (Personal Hygiene) in Bengali ; (7) A Lump of Coal ; (8) A Pinch of Common Salt ; (9) The Tip of a Match ; (10) Combustion; (11) *Cha* (Tea) in Bengali ; (12) Marriage-Dowry ; (13) *Kagaj* (Paper) in Bengali ; (14) *Puri Jaibar Pathe* (On the way to Puri) in Bengali ; (15) *Palli Swasthya* (Village Sanitation) in Bengali ; (16) The Health of Indian Students ; (17) *Pallibasir Prati Nibedan* (An Appeal to Villagers) in Bengali ; (18) Milk-supply of Calcutta ; its Hygienic, Social and Commerical Aspects ; (19) Prevention of Small Pox ; (20) A few Hints on Sanitary Reconstruction ; (21) Sir Gooroo Dass Banerjee (Life).

Honours and Decorations.

In 1921, Dr. Bose was appointed the Sheriff of Calcutta, this being the second occasion (the late Dr. Mahendra Lal Sircar, M.D., C.I.E., being the first recipient) in which a member of the Medical Profession was so honoured by the Government. During his tenure of office as Sheriff of Calcutta, two important events took place, first, the State Visit of H. R. H. the Duke

of Connaught in connection with the inauguration of the Reformed Councils in India, and secondly, the visit to India of H. R.H. the Prince of Wales against which an agitation was set on foot by a certain section of Indian politicians and Dr. Bose had to discharge the duties of his office in connection with the Royal visit under exceptionally difficult circumstances. In the words of the Hon. Sir Lancelot Sanderson, Kt., K.C., Chief Justice of Bengal, Dr. Bose had occupied this very important office with dignity and credit and had held it during a period when difficult questions had arisen, and in this sense, the duties of his office had been more responsible than those which were ordinarily attached to it and which he had discharged in a way which was satisfactory to the citizens of Calcutta.

The title of Rai Bahadur was conferred on Dr. Bose in 1898. He was appointed a Companion of the Imperial Service Order on the 3rd June, 1915.

In June 1922, on the occasion of the King-Emperor's Birth Day, Dr. Bose was made a Companion of the Order of the Indian Empire. The numerous letters of congratulations which he received from friends in India and England bore striking testimony to his popularity and the estimation in which he is held for his character and his many-sided public activities. In commenting on the honour, the Indian Journal of

Medicine (June, 1922) made the following observations;

"We congratulate Rai Dr. Chunilal Bose Bahadur C.I.E., I.S.O., M.B., F.C.S., most heartily upon the high honour conferred upon him by the King-Emperor as announced in the last Birthday Honours list. The whole of the Indian Provincial Medical Services Association and the Bengal Branch specially, will feel proud of this honour conferred upon their senior Vice-President and an Honorary Member of the Association. In him are combined the qualities of level-headedness, honesty of purpose, congenial manners and a courage of conviction which are exhibited to the highest degree and have characterised the man everywhere, whether in his capacity as Chemical Examiner to the Government of Bengal, as a member of the Senate of the Calcutta University, as Sheriff of Calcutta, as a public man, or as an earnest worker in the Social Cause. He was a most successful teacher and his scientific contributions are well known to all of us. He is the author of many books on Chemistry and Hygiene and has devoted his whole life to popularising Science for the benefit of his countrymen."

Dr. Bose married the eldest daughter of the late Babu Gour Kishore Sircar of Brahminpara in the district of Howrah and has two sons and two daughters.

PREFACE.

It is a matter of great satisfaction to me to be able to bring out in a collected form most of the important papers contributed by my father, either singly or jointly with others, to various scientific, medical and other journals during the last 34 years.

These papers have been grouped according to subject under the various heads of *Chemical and Pharmacological, Medical, Medico-legal, Industrial Chemistry, Hygiene and Public Health, Temperance, Popular Scientific Lectures* and *Miscellaneous*, and are published in two volumes arranged in their chronological order. The second volume is in the press.

A few of these papers (such as *The Necessity for an Act to restrict the Free Sale of Poisons in Bengal*) have served the purpose for which they were written and now possess only a historical interest. The others, on account of their important bearing on Analytical Chemistry, Pharmacology and Forensic Medicine, may be said to possess a perennial interest and their perusal, it is hoped, will benefit readers interested in the study of these subjects.

I have given a brief record of the life and career of my father, the main facts of which I have gathered from a paper on the subject by Dr. Satyendra Nath Sen, M.B., Assistant Chemical Examiner to the Government of Bengal and published in the Indian Journal of Medicine, Vol. I., No. 3, October, 1920. I take this opportunity to express my sense of obligation to Dr. Sen for the help I have received from his article.

With the permission of my father, I have dedicated this book to my uncle (my father's elder brother) to whose help, advice and example my father owes much for his success in life.

J. P. BOSE.

INDEX.

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A

H

Page

Page.

WORKS BY RAI CHUNILAL BOSE, BAHADUR.

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CONTENTS.

PAGE.

II. MEDICAL.

III. MEDICO-LEGAL

ILLUSTRATIONS.

I

CHEMICAL

AND

PHARMACOLOGICAL.

Surgeon-Major C. J. H. Warden, M.D., I.M.S.

Chemical Examiner, Bengal, 1880—1891.

To face page 1.

ON THE.

Analysis of Certain Samples of Tinned. Meat.*

RECENTLY, certain samples of tinned meat were examined in the Laboratory of the Chemical Examiner's Department, Calcutta, and the results are perhaps of sufficient interest to be placed on record. The samples were 6-lb. tins of the following brands :—

1.—Sydney Meat Preserving Co., New South Wales, Australia .. .. Mutton
2.—New Zealand Packing Co., Peach Brand, Auckland .. Beef.
3.—New Zealand Packing Co., Peach Brand, Auckland .. Mutton
4.—Fairbank Canning Co., Lion Brand, Chicago .. Beef.
5.—Armour Packing Co., Helmet Brand, Kansas City, U. S. A. .. .. Beef.
6.—Central Queensland Meat Export Co., Rockhampton .. Beef.
7.—Central Queensland Meat Exports Co., Rockhampton .. Mutton

Before opening the tins, their dimensions were taken, and they were weighed with labels

* By C. J. H. Warden M.D., Chemical Examiner to the Government of Bengal and Chunilal Bose, M.B., Assistant Chemical Examiner.

Published in the Chemical News, June, 1890.

intact. The results are recorded in the following Table :—

Description of Brand.	Weight (avoir) lb. oz. gr.	Dimensions in inches & tenths Height.	Top.	Bottom.
Sydney Meat Preserving Co., Mutton ..	6 15 50	8.6	4.52 × 4.23	5.1 × 5
New Zealand Packing Co., Beef ..	6 9 70	8.94	4.9 3.7	5.4 × 4.15
New Zealand Packing Co., Mutton ..	6 14 107	8.94	4.9 × 3.7	5.4 × 4.15
Fairbank Canning Co., Beef	6 14 203	9.2	5.04 × 3.41	5.7 × 4·2
Armour Packing Co., Beef	7 14 202	8.79	5.39 × 4.19	5.41 × 3.7
Central Queensland Meat Export Co., Beef	7 14 105	9.25	4.9 × 3.67	4.14 × 5.37
Central Queensland Meat Export Co., Mutton	7 1 320	9.25	4.9 × 3.67	4.14 × 5.37

All the tins were in a sound condition and free from rust externally. The Fairbank Canning Co.'s tin was coated with transparent blue varnish, and had a small paper label. The New Zealand Packing Co.'s tins were only painted, the nature of the contents being printed in black ink. The remaining tins were painted and also covered with varnished paper labels, except at the top and bottom. We would suggest in lieu of paper labels, the preferable plan of painting and stamping cases of tinned provisions with the brand, nature, and weight of the contents, and year of manufacture. This last point is one which appears to us to be of very considerable moment.

Tinned provisions are, as a rule, chiefly employed when fresh ones are unavailable; and, though tinned meats will keep for some time, they certainly do not improve by age. As at present put up, one can only roughly judge of their age by the external condition of the tin, a source of information which may obviously lead to very incorrect conclusions.

Out of the seven brands of tinned meat examined by us, only the Fairbank Canning Co.'s sample showed the date of manufacture.

All the tins were larger in area at the base that at the top; an expedient which admits of the contents being readily removed whole.

In the following Table, the weights of the empty tins and their contents are recorded:—

Brand.	Weight of empty tin.		Weight of contents.		
	ozs.	grs.	lbs.	ozs.	grs.
Sydney Meat Preserving Co. Mutton ..	15	33	6	0	16
New Zealand Packing Co. Beef ..	12	35	5	13	35
New Zealand Packing Co. Mutton	12	393	6	1	151
Fairbank Canning Co. Beef ..	13	61	6	1	141
Armour Packing Co. Beef ..	14	35	6	2	167
Central Queensland Meat Export Co. Beef ..	15	22	6	1	82
Central Queensland Meat Export Co. Mutton	14	341	6	2	417

In the majority of cases, the insides of the tins were bright and free from all traces of corrosion or rust.

In chemically examining the samples, the whole of the contents of a tin was in each ins-

tance thoroughly well pulped in a large marble mortar, and a portion of the pulped mass used for analysis. Great care was taken to thoroughly scrape the interior of the tins, so as to remove adherent fat and jelly. The tins were then warmed to melt the last traces of fat and jelly, which were also added to the contents of the mortar. The tins were subsequently washed with kerosene oil to dissolve traces of fat, and finally with soap and water, and after drying, were weighed, the weight of the contents of a tin being taken as the difference between the weight of a full and empty one. In preparing a specimen of tinned meat for analysis, to merely take a slice and to examine that appears to us to be an erroneous procedure; the contents of a tin must be considered as a *whole*, and the method we have described of sampling appears to be the only accurate plan by which a knowledge of the general nature of the contents of a tin can be obtained.

In the analysis of an article so prone to decomposition as meat, especially in the tropics, the scheme of examination has to be somewhat carefully considered. We found that certain of the determinations could be made with the meat in the freshly pulped state, while others were preferably made with the desiccated pulp. The first pulp was used for the estimation of moisture, ash, phosphoric acid, chlorine, potash and soda, and the dried meat for the determination of fat, nitrogen, and aqueous extractive.

For the estimation of moisture, five to six grms. of pulp were teased with forceps on the bottom of a flat platinum dish, and exposed at first to a temperature of 100°C., and subsequently to 120°C. in a hot air-bath. The samples were moistened once with absolute alcohol after having been heated for some hours, and the heating continued. Desiccation occupied from eight to nine hours. In another large platinum capsule, 30 or 40 grms. of pulp were similarly heated, and when crisp, reduced to fine powder and again heated. The dried pulp was preserved in a well-stoppered bottle, and used for the determinations already mentioned.

In determining ash,* the portion of the pulp used for the estimation of moisture was carbonised below redness, reduced to powder in the dish by a flat nail-headed glass rod, and the carbonaceous powder digested with hot water. The solution was then poured on a small filter, and the residue repeatedly washed with warm water. The filter containing the insoluble residue was then dried, and the particles brushed into the platinum dish, which was heated until the whole of the carbon had been consumed. The ash was again digested with warm water, and the solution passed through the same filter. The filter paper was again dried, and, finally, ignited in the dish. After deducting the filter ash, the residue re-

* The samples were examined for foreign metals—tin and lead—in the majority of cases with negative results.

presented the insoluble ash of the sample, the mixed filtrates, on evaporation and ignition just short of redness, affording the soluble mineral constituents. The filter-papers were of C. Schliecher and Schull's manufacture, and had been extracted with HCl and HF. Control experiments were also made by which the total ash was obtained at one operation. In these determinations, great difficulty was often experienced in burning off the last traces of carbon, and prolonged ignition was necessary. As will be seen from the following table, the total mineral matter obtained by adding together the soluble and insoluble ash was, as a rule, a trifle higher than the "total ash" obtained by one operation, but the difference was not so large as might perhaps have been anticipated.

Brand.	Sum of soluble and insoluble ash.	Ash by one operation.
Sydney Meat Preserving Co. Mutton ..	1.5[illegible]	1.31
New Zealand Packing Co. Beef ..	0.991	0.865
New Zealand Packing Co., Mutton ..	0.621	0.75
Fairbank Canning Co., Beef ..	1.944	1.628
Armour Packing Co., Beef ..	4.635	4.38
Central Queensland Meat Export Co. Beef	1.716	1.7
Central Queensland Meat Export Co. Mutton	1.605	—

The soluble ash was used for the estimation of soda and potash by being dissolved in water, and barium chloride, ferric chloride and ammonia added successively, and heated for

some time; the precipitate was then filtered off, washed, and the filtrate, after the addition of ammonium carbonate and oxalate, warmed for some time on the water-bath, and filtered. The filtrate and washings were then evaporated to dryness and gently ignited to remove ammonium salts. On adding water to the residue, a trace of insoluble matter was filtered off, and the filtrate, after the addition of a few drops of HCl, evaporated to dryness with an excess of platinic chloride. This method of treating the ash of meat preparations is essentially the one described by Dr. A. Stutzer.*

In estimating the alkali metals, we employed the following indirect method:—

The residue obtained, as described above, consisting of the double sodium-potassium and platinum chlorides, was treated with alcohol and ether in the usual manner, but instead of weighing the potassium-platinum chloride, it was ignited at a low temperature with the filter-paper on which it had been collected, the residue exhausted with warm water, and the solution of chloride of potassium titrated with standard silver nitrate. The alcoholic solution containing the sodium-platinum salt and an excess of platinum chloride was evaporated to dryness in a small beaker, and the residue washed into a platinum crucible. Ammonium chloride was

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* Analyst, p. 57, 1885.

then added in more than sufficient quantity to combine with the platinum, the mixture evaporated to dryness, and the crucible cautiously heated, first without its cover, and then covered. The residue was treated with warm water, and the chlorine estimated with standard silver nitrate. The two chlorine titrations thus afforded data from which the amount of K_2O and Na_2O in the ash could be calculated. In carrying out this method of estimating the alkali metals, care must be taken not to under or over-heat the residues. Intense ignition would entail loss of chlorides; while by under-heating, the whole of the double alkali-platinum-salt would escape decomposition, and on adding water to the contents of the crucible, the solution would have a yellowish colour; in which case, it would be requisite to evaporate the solution and again ignite. We did not find it necessary to separate the finely-divided platinum from the solution of the chloride before titration with silver.

In order to test the accuracy of alkali determinations made in this indirect manner, the following control experiments were performed:— A solution of pure potassium nitrate and sodium chloride was prepared containing 1.1366 grms. KNO_3 and 0.5326 grm. NaCl in 100 c.c. of distilled water. Of this solution, we took 10 c.c. for analysis, and duplicate determinations were made by each of us with the following results:—

Standard solution, containing, per cent.			
KNO_3.	K_2O.	NaCl.	Na_2O.
1.1366	0.529	0.5326	0.273
1.1366	0.529	0.5326	0.273
1.1366	0.529	0.5326	0.273
1.1366	0.529	0.5326	0.273

Found by analysis, per cent.			
KNO_3	K_2O.	NaCl.	Na_2O.
1.237	0.577	0.4783	0.2557
—	—	0.4478	0.2373
1.260	0.590	0.430	0.228
1.250	0.586	0.427	0.225

The mean of these experiments shows the error of the process to be as follows :—

	Theory.	Found.	Error.
KNO_3	1.1366	1.2490	+0.1124 per cent.
K_2O	0.529	0.5843	+0.0553 „
NaCl	0.5326	0.4457	−0.0869 „
Na_2O	0.2730	0.2365	−0.0365 „

In the ordinary indirect estimation of the alkali metals, whether as chlorides or sulphates, or by Rose's method, in which the sodium-platinum chloride is decomposed and the sodium chloride extracted by water, gravimetric estimations are generally made. It is hardly necessary to indicate that when only very small amounts of salts have to be estimated, that greater accuracy is likely to result from volumetric than gravimetric methods of estimation. The method we have described appears to yield fairly accurate results, and is specially applicable to cases in which small amounts of sodium and potassium have to be estimated.

For the estimation of chlorine and phosphoric acid, about 20 grms. of the fresh pulped meat were carefully weighed in a platinum dish and mixed with about 2 grms. of pure sodium carbonate,* dissolved in sufficient water to cover the pulp. The resulting magma was evaporated to dryness, carbonised below redness, and the residue first extracted with water and then with nitric acid, the solution being passed through a filter. The residue on the filter was dried and added to any particles remaining in the dish. The carbonaceous residue was then ignited until the whole of the carbon was consumed, the ash was again treated with dilute nitric acid, the solution being passed through the same filter; the filtrate and washings being collected in a 250 c.c. flask. The resulting solution was turbid from precipitation of phosphate of lime, the amount of nitric acid and ash being sufficient to neutralise the carbonate of soda. The alkaline solution was consequently rendered faintly acid by acetic acid, and diluted up to 250 c.c. A portion of this solution was used for the estimation of chlorine. The greater part was concentrated and the phosphoric acid precipitated with molybdenum, but partially wieghed as the phosphate of magnesium.

In the dried pulps, nitrogen was determined by Kjeldahl's method, and the results calculated

* The addition of sodium carbonate is recommended by Dr. Stutzer to prevent the formation of pyrophosphoric acid and the volatilisation of small quantities of chlorine during ignition.

back into the moist meat. The albumenoids were calculated from the nitrogen by using the factor 6.25.

The boiling water extractive was determined by boiling one grm. of the dry pulp with distilled water in a 100 c.c. flask, and, when cold, diluting up to 100 c.c. The liquid was then passed through a dry filter, and a portion of the very faintly opalescent filtrate evaporated to dryness in a platinum capsule for dissolved solids. The greater part of the filtrate was measured into an Erlenmeyer's flask, which was placed in boiling water until the water was evaporated off, and the extractive left as a varnish at the bottom of the flask. Sulphuric acid was then added to the dry residue in the flask for estimation of the nitrogen by Kjeldahl's method.

Fat was determined by very carefully weighing 0.5 to 0.6 of a grm. of the dry pulp into a small accurately stoppered weighing bottle, and adding a measured volume of light petroleum ether from a burette. The mixture was allowed to digest with agitation for about two days, then allowed to clear by subsidence, and a portion of the perfectly clean supernatant liquid withdrawn by a small burette, and a carefully measured volume discharged into a tared beaker. After evaporating off the ether, the residual fat was heated to 100°C. and weighed. No correction was applied for increase in volume of the petroleum spirit due to dis-

solved fat. This method is one suggested by Dragendorff,* for the estimation of oil, in his scheme for the systematic analysis of vegetable substances by the aid of various solvents. As a control experiment, one of us estimated the fat in a sample in the manner described, while the other determined it by thoroughly exhausting a portion with petroleum ether with the following results:—

a. By Dragendorff's method, fat=15.016 per cent.

b. By thorough exhaustion, fat=15.030 per cent.

Working in the manner indicated, the general results of the determination of the samples are shown in page 16.

In order to compare the composition of tinned with fresh meat, the following analyses by Konig† of fresh meat are appended.

Nature of samples.	Water.	Albumenoids.	Fat.	Ash.
Very fat ox flesh, mean of 7 analyses	55.42	17.19	26.38	1.08
Moderately fat ox flesh, mean of 21 analyses:				
Minimum	68.50	16.23	1.17	0.71
Maximum	78.00	25.35	9.50	1.95
Mean	73.25	20.78	5.33	1.33
Lean ox flesh, mean of 9 analyses	76.71	20.78	1.50	1.18
Fat cow flesh, mean of 9 analyses	70.96	19.86	7.70	1.07
Lean cow flesh, mean of 6 analyses	76.35	20.54	1.78	1.32
Very fat mutton, mean of 3 analyses	47.91	14.80	36.39	0.85
Moderately fat mutton, mean of 8 analyses	75.99	17.11	5.77	1.33

* "Plant Analysis." † Zusammensetzung der menschlichen Nahrungs und Genussmittel.

It will be observed from a comparison of the tinned and fresh meat samples, that while the percentage of moisture in the former is in the majority of instances lower, the fat in the tinned meat, as a rule, exceeds the amount present in fresh meat. From a purely chemical point of view and taking the albumenoids as representing the standard of nutritive value, the tinned meats are richer in that constituent, weight for weight, than fresh meat. But as the dietetic value of water need not be taken into consideration, and as the fat in the tinned meat samples is higher, as a rule, than in the fresh meat, it is worth while comparing anhydrons fat-free tinned meat with fresh meat under similar conditions as regards the nitrogen content.

Description of samples.	Nitrogen in anhydrous meat.	Fat in anhydrous meat.	Nitrogen in anhydrous and fat-free meat.
New Zealand Packing Co. Beef	10.913	24.236	14.39
Fairbank Canning Co. Beef	8.932	36.137	13.98
Armour Packing Co. Beef	8.090	37.845	13.01
Central Queensland Meat Export Co. Beef ..	8.247	43.310	14.54
Sydney Meat Preserving Co. Mutton ..	9.700	32.960	14.31
New Zealand Packing Co. Mutton	9.556	31.141	13.89
Central Queensland Meat Export Co. Mutton ..	9.518	30.357	13.66
Fresh very fat ox flesh ..	6.180	59.010	15.07

Description of samples.	Nitrogen in anhydrous meat.	Fat in anhydrous meat.	Nitrogen in anhydrous and fat-free meat.
Fresh moderately fat ox flesh Minimum ..	9.360	4.250	9.77
Maximum ..	14.620	34.240	22.23
Mean ..	12.090	18.630	14.84
Fresh lean ox flesh ..	14.200	6.390	15.26
Fresh fat cow flesh ..	11.300	25.530	15.03
Fresh lean cow flesh	13.930	7.250	15.01
Fresh very fat mutton ..	4.690	68.770	15.02
Fresh moderately fat mutton	11.450	23.700	15.01

The results of analysis arranged in the manner shown in the last Table indicate that the anhydrous and fat-free flesh of the tinned meat samples is, when compared with fresh meat, distinctly lower in nitrogen, and consequently less rich in albumenoids. Taking the mean, and calculating the nitrogen into albumenoids by the factor 6.25, the following figures are obtained :—

Nature of samples.	Albumenoids in anhydrous and fat-free samples. Per cent.
Mean of all tinned beef	87.062
Mean of all tinned mutton	87.187
Mean of all fresh cow and ox flesh ..	93.936
Mean of all fresh mutton	93.812
Mean of all tinned meat samples ..	87.124
Mean of all fresh meat samples ..	93.874

Konig in his work, to which we have already referred, quotes seven analyses by various chemists of tinned meats, the analyses having been made between the years 1878—80; the results are given in table (see page 17).

The tinned meat samples compared with fresh roast meat also appear to show a slight diminution in albumenoids. An analysis by John Ranke, quoted by Pavy,* gives the composition of roast meat (nature not indicated), no dripping being lost, as follows :—

Albumenoids	..	.. 27.60 per cent.
Fat	..	.. 15.45 ,,
Salts	..	.. 2.95 ,,
Water	..	.. 54.00 ,,

* "Treatise on Food and Dietetics."

RESULTS OF ANALYSIS OF THE SEVEN SAMPLES OF TINNED MEAT.

Description of brand.	Moisture at 120° C.	Fat.	Nitrogen.	Albumenoids N × 6.25.	Total ash.	Ash soluble in water.	Ash insoluble in water.	Chlorine (Cl.)	Phosphoric anhydride (P_2O_5).	Oxide of potassium (K_2O).	Oxide of sodium (Na_2O).	Boiling water extractive per cent in meat.	Nitrogen in boiling water extractive per cent in meat.	Meat bases and in boiling water extract = N × 6.25.
Sydney Meat Preserving Co. Mutton	54.700	15.030	4.40	27.500	1.5302	1.3039	0.2263	0.544	0.345	0.364	0.417	7.249	0.906	5.660
New Zealand Packing Co. Beef	57.350	10.338	4.65	29.062	0.991	0.665	0.326	0.146	0.359	0.220	0.117	6.953	1.000	6.250
„ „ Mutton	55.000	14.000	4.30	26.275	0.621	0.189	0.432	0.112	0.391	0.136	0.067	5.353	0.900	5.6[illegible]
Fairbank Canning Co. Beef ..	56.039	15.829	3.93	24.562	1.944	1.778	0.165	1.107	0.308	0.262	0.807	7.159	0.879	5.493
Armour Packing Co. Beef ..	50.650	18.660	3.99	24.937	4.365	4.176	0.189	2.650	0.318	0.434	0.963	10.414	0.987	6.168
Central Queensland Meat Export Co. Beef	49.050	22.080	4.20	26.25	1.716	1.474	0.242	0.999	0.402	0.230	0.609	7.951	1.010	6.312
„ „ Mutton	52.600	14.390	4.51	28.187	1.605	1.244	0.361	0.847	0.329	0.237	0.458	9.464	1.100	6.875

Analysis of Tinned Meat (Quoted by Konig).

Description of samples.	Water.	Albumenoids.	Fat.	Ash.	In anhydrous samples. Nitrogen	In anhydrous samples. Fat.	Albumenoid in anhydrous and fat-free Sample.
Wilson Export Co.	57.3	28.9	10.2	3.6	10.83	23.75	88.75
(*) Canning and Co. Export Co. ..	49.2	25.7	21.6	3.5	8.09	42.52	87.93
Brougham Export Co.	48.9	27.7	19.0	4.4	8.67	37.18	86.25
From Australia	54.03	29.31	12.11	4.55	10.20	26.34	86.50
Pressed corned beef, from Chicago ..	56.9	33.8	6.4	2.9	12.55	14.85	91.06
2-lb. tin containing 1020 grms. ..	57.7	31.5	7.3	3.5	11.91	17.62	92.81
4 lb. tin containing 1844 grms ..	58.8	25.9	11.8	3.5	10.05	28.64	87.12
Mean	54.69	28.97	12.63	3.71	10.33	27.27	88.63

Calculating the albumenoid on the anhydrous and fat-free meat gives 90.34 as the percentage, figures which are also higher than the albumenoid content of the tinned meats. According to Playfair's experiments, it would appear that in roasting meat, the loss is chiefly water, the proportion of carbon, hydrogen, nitrogen, and oxygen remaining the same.*

Summarising we may state that our results generally confirm those of other analysts, as indicating the lower nutritive value of tinned when compared with fresh meat. Our inferences are based on purely chemical data, but on physiological grounds, there can also be no doubt that sodden tinned meat would be less easily assimilated than ordinarily cooked flesh, and that consequently its dietetic value would be even less than is indicated by its chemical composition.†

* Parkes's "Hygiene."

† The above process of analysis has been bodily adopted in Allen's Commercial Organic Analysis (4th Edition, Vol. VIII., pages 331-336) being described as "*unusually complete analyses of typical samples* of canned beef and mutton."—EDITOR.

Note on certain reactions of an alkaloid contained in the roots of Rauwolfia Serpentina, Benth.*

In the *Pharmacographia Indica*, Vol. II., p. 416, one of us described the proximate composition of the root of the *Rauwolfia Serpentina* Benth., and noted the presence of one or more alkaloidal principles. This communication deals chiefly with the colour reactions of an alkaloid which we have separated from the roots, and provisionally termed pseudobrucine.

The isolation of the alkaloid in a pure condition was attended with difficulty. In our first experiments, the pounded root was exhausted with boiling 80 per cent. alcohol, and the alcohol-free extract treated with cold water acidulated with sulphuric acid, by which a large amount of dark resinous matter was separated. The aqueous acid solution was then precipitated with Mayer's reagent, but the precipitate on decomposition did not yield the alkaloid in a

* By C. J. H. Warden, M.D., and Chunilal Bose, M.B. Pharmaceutical Journal, August, 1892.

pure condition, owing to a certain amount of resinous matter being precipitated with the alkaloid by the reagent, and which was subsequently dissolved by the amylic alcohol employed to separate the alkaloid after its liberation from the mercury compound. Attempts were made to separate dissolved resinous matter from the aqueous acid solution of the alkaloid by agitation with amylic alcohol, but the sulphate of the alkaloid was freely soluble in this alcohol. In ether, the alkaloid was only very slightly soluble. Ultimately, the pounded root was percolated with chloroform, the chloroform evaporated off, and the extract treated with water acidulated with sulphuric acid. The acid aqueous solution of the alkaloid was then agitated with chloroform, which separated some colouring matter and a trace of alkaloid. The chloroform was then separated and the acid solution made alkaline with sodic carbonate and reagitated with chloroform, this series of operations being repeated several times. The final chloroform extract was dried and agitated with ether, which removed traces of colouring matter. The extract now formed a cinnamon-coloured powder, extremely bitter, soluble in dilute acids, and dissolving in amylic alcohol or chloroform with a very marked greenish fluorescence. An alcoholic solution of the alkaloid did not crystallize, and we failed in obtaining distinctly crystalline salts. A solution of the alkaloid in dilute sulphuric acid

afforded with alkaline carbonates and hydrates a bulky white precipitate; but even after repeated precipitation and re-solution, the physical characters of the alkaloid were not materially altered, and its solution in amylic alcohol or chloroform still showed a marked fluorescence. A solution of the alkaloid in dilute sulphuric acid, when agitated with animal charcoal, completely lost its bitterness, the solution being at the same time completely decolourised. The alkaloid could be again separated from the charcoal by treatment with warm alcohol, the physical characters being unaltered.

The following colour reactions were noted, pure brucine being tested at the same time as a control:—

Reagent.	Brucine.	Alkaloid suspected to be Brucine.
Conc. sulph. acid containing a trace of nitric acid	Pink ..	Yellow.
Conc. hydroc. acid ..	Colourless ..	Yellow.
Acetic acid ..	Colourless ..	Yellow.
Conc. nitric acid ..	Scarlet, soon passing into yellow.	Scarlet, does not become yellow so soon as the brucine, but only after standing for some time
Sulph. acid and bichromate of potash	Yellow, with tinge of red	Slight purple, not unlike the strychnia reaction, but not so marked.
Sulph. acid and MnO_2	Orange ..	Violet, changing to dark brown.
Chlorine ..	Red; colour soon discharged, decolourised by ammonia.	Red; colour not so soon discharged, decolourised by ammonia.

Reagent.	Brucine.	Alkaloid suspected to be Brucine.
Mercurous nitrate, with slight excess of HNO_3. ..	Pink on warming, colour deepens on standing.	Yellow on warming, but no pink colour.
Mayer's reagent ..	Pale yellowish ppt., flocculent.	Pale yellowish ppt., flocculent.
Nitric acid and $SnCl_2$.	Purple, discharged by excess of both reagents.	No purple colour.
Sulphuric acid and potassium nitrate.	Red, changes soon into yellow.	Red, with greenish-purple tint at the edges, red colour deepens on standing
Sulphocyanide of potassium.	White ppt., sol. in excess of acetic acid, repptd. by NaHO.	White ppt., sol. in excess of acetic acid, repptd. by NaHO.
Bichromate of potassium in acetic acid solution.	Copious yellow ppt., with difficulty soluble in large excess of acetic acid.	Copious yellow ppt. with difficulty soluble in large excess of acetic acid.
Platinic chloride.	Thick yellowish floc. ppt., with difficulty soluble in acetic acid but with exception of a few flocks completely soluble in NaHO.	Thick yellowish floc. ppt., readily soluble in acetic acid, but almost insoluble in NaHO.
Auric chloride. ..	Dirty white floc. ppt., soon changing to flesh colour, soluble in excess of acetic acid, but insol. in NaHO.	Beautiful purplish-red ppt., soon changing to dirty brown, with a green tinge, sol. in excess of acetic acid, but insol. in NaHO
Potassium ferrocyanide.	Light yellow ppt., soluble in dilute H_2SO_4. The presence of acetic acid in slight excess prevents precipitation.	Light yellow ppt., sol. in dil. H_2SO_4. The presence of acetic acid in slight excess does not prevent precipitation.
Alcoholic solution of iodine.	Alcoholic solution of alkaloid, rosette crystals.	Alcoholic solution of alkaloid, no crystaline forms on microscopic examination.

Two experiments were made to determine whether the alkaloid possessed any physiological properties similar to brucine. In the first experiment, 0.15 gramme was dissolved in three drops of acetic acid diluted with about two drachms of water, and injected into a cat's stomach at 11-21 A.M.

11-37 A.M.—A quantity of half-digested food was vomited; there was a good deal of frothy mucus and constantly dribbling saliva, movement of the jaws, and application of the paws to the mouth as if to remove some irritant matter; the animal restless and much distressed.

12-30 P.M.—Frothy mucus and saliva still flowed from the mouth, but in smaller amount; vomiting ceased, but now and then retches; animal not so restless.

1 P. M.—Discharge of saliva ceased; animal quiet, no further symptoms developed.

In the next experiment, .022 gramme of the alkaloid was dissolved in acetic acid, the solution evaporated to dryness, the residue dissolved in a few drops of distilled water, and the solution hypodermically injected into the left hind leg of a small frog at 11-40 A.M. The frog was placed under a large glass funnel and jumped about, a tap on the glass being sufficient to make it change its place.

11-44 A.M.—Frog showed no inclination to move; when its back was touched with a glass rod, it made feeble attempts to move its limbs; some loss of power was evident, but there were

no twitchings of the limbs or convulsive movements.

11-46 A. M.—The frog did not move its limbs even when tapped on the back; the left leg appeared quite paralysed.

11-50 A. M.—The limbs were quite lax, and might be placed in any position without the animal making any effort to move them. When placed on its back, it now and then made feeble attempts to move the right leg; then the movements simulated slight twitchings. After this, and until its death at 12 noon, it lay motionless. the only sign of vitality being an occasional gasp; limbs flaccid, no convulsions. As a control experiment, another frog, a little larger, was injected with the same amount of brucine. Two minutes after the injection, it was perfectly motionless; there was evidently loss of voluntary power over the limbs. When placed on its back and touched. it made no effort to move, but slight twitchings of the limbs were noticed which became more marked in about a couple of minutes. Touching the back, pinching the limbs. or even gentle tapping on the table, was now sufficient to produce rather feeble convulsive movements, but there was no spasm, except when thus regularly induced. The frog died about ten minutes after the injection. After death, the limbs were not stiff but rather flaccid.

Many of the reactions we have described as being afforded by the alkaloid we have provisionally termed pseudobrucine, were identical

with those yielded by brucine; while, on the other hand, certain reactions were quite different. The history of the drug shows that it is employed as a domestic remedy in the treatment of a large number of affections, but there is no evidence to indicate that it is supposed to possess any toxic properties. When we are satisfied that we have obtained the alkaloid in a pure state, its ultimate composition, &c., will be determined.

False Bikh or Bikhma.*

Towards the end of 1891, certain medico-legal exhibits were received in the Chemical Examiner's Department, Calcutta, from the Monghyr District, including a parcel of roots labelled *Bikhma*. Bickhma or Bishma, we may mention, is the vernacular name for *Aconitum Palmatum*. Specimens were sent for identification to the Calcutta Bazaars, and recognized as Bikhma; we also forwarded some to Nepal, where it was recognized and stated to be sold as Bikhma in the Bazaars. Up to this period, we had had no opportunity of examining authentic specimens of Bikhma, and being doubtful whether the drug we had received from Monghyr was true Bikhma or not, we forwarded a sample to Dr. Dymock, Bombay, who reported as follows:—"They appear to be the rhizomes of an aroid, and are not unlike those of the genera Lagenandra, Arum, and Cryptocoryne. They have been cured by some smoking process, have a strong tarry odour, and are somewhat translucent, tough and flexible. They have no resemblance in structure to any kind of

* By C. J. H. Warden, M. D. and Chunilal Bose, M. B. Pharmaceutical Journal, October 15th, 1892.

aconite. I have never seen them before." Dr. D. Prain, of the Royal Botanic Gardens, Seebpore, to whom we also submitted a specimen, wrote :—"I cannot identify it for certain, but it is, I think, a leguminous rhizome. It might be a glycyrrhiza." Subsequently, Dr. Dymock kindly sent us a specimen of true *A. Palmatum*: "some of the same batch I sent to Fluckiger, and which was examined by Shimoyama. I kept it as being a remarkably fine sample ; as the drug is expensive, it may be adulterated with aconite. Rs. 6 per lb. is the price, and aconite is only 9 annas." His sample, when compared with ours, was wholly dissimilar. Under the circumstance, we thought it might be of interest to examine the spurious Bikhma, and our results are embodied in this note. In the condition in which the roots were received, they were so horny that it was impossible to powder them, and they were cut into fragments, exposed to a temperature of about 80°C. for some time, alllowed to cool, and then at once pulverised. During the process, the dust caused watering of the eyes and sneezing. When dried at 100°C., the powder lost 6.23 per cent. of moisture. In extracting the powder, 315.5 grammes were exhausted with boiling rectified spirit, and the tincture evaporated on a water-bath until it ceased to smell of alcohol. The resulting extract was of a dark brown colour and of the consistence of treacle. The marc left after extraction with boiling spirit was re-per-

colated with 250c.c. cold spirit containing 1 per cent. of tartaric acid, and the spirit evaporated off at a low temperature. The two extracts were now mixed with water containing 2.5 grammes of tartaric acid, and the mixture agitated with light petroleum ether. During agitation, a few yellowish flocks separated. The petroleum ether extract amounted to 1.173 per cent. calculated on the root containing 6.23 per cent. of moisture. The petroleum ether extract was yellowish-brown in colour, semi-solid in consistence, and waxy in odour. The taste was nauseous, recalling croton oil. In absolute alcohol, it was wholly soluble with strongly acid reaction. On spontaneous evaporation of the alcoholic solution, a yellow transparent mass was left at the bottom of the beaker, while on the sides, the deposit was yellowish-white and opaque. On microscopic examination, it appeared as minute needle-shaped crystals. An attempt was made to separate the petroleum ether extract into fractions, and with this object, it was gently warmed with proof spirit, which dissolved a certain amount, and the extract was thus roughly divided into a soluble and insoluble residue. The proof spirit solution, on spontaneous evaporation, deposited soft orange resinous matter, while some white deposit separated on the sides of the capsule. This was found to consist of oil globules, and a few minute needle-shaped crystals. In addition to oil and resinous matter

possessing an acid reaction, the presence was also detected of an alkaloidal principle soluble in ether, which afforded marked indications with the usual reagents. With Fröhde's reagent, no change was observed in the cold, but a dirty blue developed on gently warming. The portion of the petroleum ether extract insoluble in proof spirit was boiled with alcoholic potash, the solution evaporated to dryness and treated with water. The aqueous solution was turbid from the separation of brown flocks. The turbid solution was agitated with petroleum ether. The ethereal extract had a camphoraceous and terebinthinate odour, was of an orange colour, and had a melting point of 62°C. It was not further examined. The aqueous soap solution was decomposed by dilute sulphuric acid and agitated with ether. The ether extract was converted into a lead soap and reagitated with ether. The soluble lead soap, after separation of lead, afforded a residue which was liquid at ordinary temperatures and of a reddish-brown colour. When agitated with a freshly prepared solution of nitrate of mercury, it solidified to a yellowish mass. The insoluble lead soap, after separation of lead, afforded a residue which was solid at ordinary temperatures, and had a melting point of 48°. Neither of these fatty extracts was pure, and no attempt was made to ascertain whether they consisted of single acids or mixtures. The presence of glycerine was determined in the

original aqueous sulphuric acid solution. The aqueous acid solution of the alcoholic extract of the roots, after treatment with petroleum ether, was agitated with ether. The ethereal solution was allowed to evaporate spontaneously, and the final desiccation conducted over sulphuric acid. The non-crystalline residue was dark brown and sticky with tar-like odour ; it amounted to ·123 per cent., calculated on the roots containing 6.23 per cent. of moisture. Warmed with distilled water, a part of the extract dissolved, the solution affording the following reactions :—

Reaction, strongly acid.

$Fe_2\,Cl_6$ gave a dirty greenish colouration passing rapidly to dirty brownish.

$AgNO_3$, slight turbidity; on warming Ag reduced.

Aqueous NH_3, orange yellow colouration

Acetate of lead, dirty yellowish-white ppt.

Gelatine, no precipitate.

KCN, no reaction.

That portion of the ether extract insoluble in warm water was treated with aqueous NaHO, and the dark brown solution which resulted agitated with ether. The ether solution exhibited slight fluorescence, and on spontaneous evaporation afforded a yellow crystalline deposit which appeared as needles and rosettes on microscopic examination. By treating this residue with proof spirit, a certain amount of neutral

resinous matter of a yellow colour was separated. This was precipitated on dilution with water. The insoluble crystalline residue afforded no crystalline sublimate when heated between watch glasses. The aqueous soda solution of the ether extract was mixed with dilute sulphuric acid and reagitated with ether. The ethereal extract was of a yellowish-brown colour, strongly acid in reaction, and had the properties of an acid resin.

The tartaric acid solution of the alcoholic extract of the drug was now mixed with a very slight excess of sodium bicarbonate and again agitated with ether. After agitation and on subsequent standing, a small quantity of a white crystalline substance separated, which floated on the water stratum below the ether. The ether was separated and allowed to evaporate spontaneously, the extract amounted to .048 per cent.; it formed a yellow transparent varnish on the sides of the capsule, while at the bottom it was white, chalky, and indistinctly crystalline; odour, armoatic. The chalky deposit consisted of some irregularly-shaped plates and amorphous particles. The yellow varnish-like residue was easily soluble in proof spirit, but neither this portion nor the chalky deposit afforded any reaction with alkaloidal reagents. The chalky deposit treated with concentrated H_2SO_4 afforded a yellow solution in the cold, changing to pinkish on standing for some time, but on heating, the pink colour was

developed rapidly. Nitric acid—no reaction. Fröhde's reagent, greenish in the cold, passing to blue on warming. Ferric chloride, no reaction. Heated with dilute aqueous H_2SO_4 and the solution neutralised, it reduced an alkaline copper solution on boiling. When agitated with water, considerable frothing was noted. A small amount injected, mixed with water, into a cat's stomach induced no symptoms. When applied to a cat's eye, there was no change in the size of the pupil observed. The yellow varnish-like deposit separated from the chalky deposit, by the action of proof spirit, when injected into a cat's stomach caused the animal to vomit once a small quanity of frothing liquid, one formed stool was also passed, but no other symptoms were noted. The varnish-like residue, when applied to the tip of the tongue, produced a slight sensation of tingling or numbness, which lasted for a short period, and could not be mistaken for the symptoms induced by aconitine.

The alkaline aqueous solution of the alcoholic extract was next agitated with chloroform. The extractive was yellowish-brown, with an odour like that of gum benzoin, and amounted to .064 per cent. In *cold* proof spirit, it was partly soluble, the solution on spontaneous evaporation affording a residue which contained a few microscopic plates. The residue insoluble in cold proof spirit was pale yellow and soluble in boiling proof spirit. On spontaneous eva-

poration, a white crystalline deposit was obtained, consisting of bundles of rods and a few plates. The residue frothed when agitated with water, and when treated with concentrated sulphuric acid yielded a rose coloration. The alkaline aqueous solution of the alcoholic extract was finally agitated with amylic alcohol. The extract amounted to 1.582 per cent., and formed a transparent, soft, viscid residue of a reddish-yellow colour, non-crystalline, and frothing considerably with water. In warm water, it dissolved, forming a clear solution, which became turbid on cooling. An attempt was made to decolourise the aqueous solution by agitation with purified animal charcoal, but very little colouring matter was thus removed. As neutral salts, as NaCl, $MgSO_4$, gave a white curdy precipitate from the aqueous solution of the extract, an attempt was made to separate the saponin-like principle by saturating the watery solution with $MgSO_4$; it was found, however, that the flocks agglutinated together, forming a sticky mass, and filtration was impossible. Baryta water was next used for separating the principle. With this object, the amylic alcohol extract was dissolved in water and excess of aqueous barium hydrate added. The turbid mixture was then filtered (filtrate A), the precipitate was washed with baryta water and transferred to a beaker, water added, and CO_2 passed for a considerable time. The turbid mixture was then evaporated to dryness on a

water-bath, and exhausted with rectified spirit, the filtered alcoholic solution was evaporated to dryness, and left a scaly, friable, shining residue, which afforded the following reations:—With concentrated H_2SO_4 a yellow coloration, changing to red. Concentrated HNO_3, yellow. In concentrated HCl, it dissolved freely, forming a faint pinkish coloured solution, the colour deepening on the application of heat, and a few flocks separating. In strong acetic acid, it was also readily soluble, forming a colourless solution, no change being induced by the subsequent addition of potassic dichromate. When heated with aqueous phosphoric acid, it did not yield a clear solution, no colour developed, and no odour. With aqueons ammonia, it was sparingly soluble; no precipitate with acetic acid; the ammoniacal solution frothed on agitation. Boiled with dilute HCl, it afforded a solution which reduced alkaline copper. The amount of principle precipitated by baryta was small, and although this principle afforded some of the reactions of saponin, it seemed probable that the greater part was still present in the filtrate.

A fresh portion of the original amylic alcohol extract was dissolved in water, and treated with lead acetate, which afforded a white curdy precipitate, after separation of lead by H_2S, yielded extracts which frothed strongly on agitation with water, and gave some of the reactions of saponin. The amount of extractive yielded was, however, small and it

appeared to us that probably both the lead precipitates were either unstable compounds of a saponin with that metal, from which the greater part of the principle could be separated by washing, or that they consisted chiefly of easily soluble lead salts of a saponin, or of a lead salt of a saponin mechanically mixed with a saponin precipitated by the action of lead acetate, in the same manner as we have found certain neutral salts to act. But, on the other hand, it was possible, assuming the extistence of more than one saponin-like principle in the plant, that one saponin formed a stable and insoluble lead compound, the other an unstable or soluble salt. And similar remarks might also apply to the barium hydrate precipitate.

As bearing on these points, the following experiments were made :- The amylic alcohol extract was dissolved in water, excess of lead acetate added, and the turbid mixture repeatedly agitated with amylic alcohol. During agitation, the greater part of the precipitate agglutinated, forming a yellow viscid coating on the bottom and sides of the bottle. This deposit appeared to be very slightly soluble in amylic alcohol. It was soluble in acetic acid, and the acid solution, when agitated with amylic alcohol, afforded an extract which frothed with water, and yielded certain of the reactions of saponin. The viscid deposit from which this extract was obtained would, therefore, appear to represent a saponin, which formed a stable

lead compound, only slightly soluble in amylic alcohol. The original amylic alcohol solution was next examined to ascertain if it contained any saponin-like principle or not. It was first filtered, and then evaporated to dryness on water-bath. The residue was yellowish and brittle, and contained a small quantity of lead. The amount of extract was far larger than that obtained from the viscid deposit after decomposition with acetic acid. Lead was removed by dissolving the extract in water and passing H_2S. The filtered solution was then evaporated to dryness, the residue reduced to fine powder and repeatedly agitated with ether, which removed some colouring matter and traces of amylic alcohol. The resulting powder was white and free from odour. It afforded the following reactions:—With cold water, it formed a slightly opalescent solution, which frothed considerably on agitation. Concentrated H_2SO_4, at first faint yellow, changing to pink, carmine, with violet at the edges on standing, and green on the addition of potassic dichromate. Concentrated HNO_3, colourless, yellow on the addition of dichromate, and changing to blue on standing for some time. In concentrated acetic acid, readily soluble, forming a colourless solution. Soluble in dilute ammonia, forming a solution which frothed, and from which acetic acid gave a white precipitate on neutralisation. Caustic soda, similar reactions to ammonia. Tannic acid, a white precipitate. Ferric chlo-

ride, a turbidity in the cold, which disappeared on heating, the solution being of a brown colour. On boiling with dilute HCl, dark brown, oily globules separated, and the solution reduced alkaline copper. This decomposition product did not appear to possess the properties of the principle described as *sapogenin*, obtained by the action of dilute acids on ordinary saponin. The ash amounted to .47 per cent.: it was free from lead.

To determine the ultimate composition of this saponin, it was dried over sulphuric acid in a vacuum, and the combustion made in an open tube in a current of oxygen, and the results afforded the following percentages:—

	Exp. 1.	Exp. 2.	Mean.
Carbon ..	60.92	61.18	61.05
Hydrogen ..	8.93	8.74	8.84
Oxygen	30.15	30.08	30.11
	100.00	100.00	100.00

From these percentages, a formula $C_{32}H_{54}O_{12}$ was deduced-

	Calculated for $C_{32}H_{54}O_{12}$	Found.
Carbon ..	60.95	61.05
Hydrogen ..	8.57	8.84
Oxygen ..	30.48	30.11
	100.00	100.00

In another experiment, a somewhat different

mode of extracting the saponin was adopted. An alcoholic extract was obtained from another sample of *Bikhma*, no acid being used in the extraction. The alcoholic extract was mixed with water and directly extracted with amylic alcohol, without previous treatment with petroleum ether, ether, and chloroform. The amylic alcohol containing the crude saponin was separated, filtered, and then repeatedly agitated with aqueous basic lead acetate. During agitation, the yellow viscid matter, already mentioned, separated on the sides of the bottle. The agitation with basic lead was continued for a considerable time, until colouring matter ceased to be dissolved. The amylic alcohol was then allowed to stand for some days, filtered, and evaporated on a water-bath. The extract was next taken up with water, and lead removed by H_2S. After filtration, the solution was again evaporated to dryness, the extract reduced to powder, and repeatedly agitated and digested with ether. The saponin extracted in this manner had a faintly yellowish colour, and contained 6 per cent. of ash free from lead. After drying over sulphuric acid *in vacuo*, the following results were obtained on ultimate analysis :—

	Exp. 1.	Exp. 2.	Mean.
Carbon ..	60.12	60.21	60.165
Hydrogen ..	8.35	8.54	8.445
Oxygen ..	31.53	31.25	31.390
	100.00	100.00	100.000

Some of the saponin used for the last analysis was subjected to a further process of purification. It was dissolved in amylic alcohol, and the solution repeatedly agitated with aqueous barium hydrate. On evaporating the amylic alcohol solution to dryness, and heating the powdered extract with ether to separate traces of amylic alcohol, the saponin was left as a white powder which contained .308 per cent. of ash. On ultimate analysis, the following percentages were obtained, the saponin being dried *in vacuo* over sulphuric acid :—

	Exp. 1.	Exp. 2.	Mean.
Carbon ..	59.90	59.82	59.86
Hydrogen ..	8.64	8.62	8.63
Oxygen ..	31.46	31.56	31.51
	100.00	100.00	100.00

It seems likely to us that the last sample of saopnin isolated was the purest of the three examined, though we are not prepared to definitely assert it was a *pure* saponin. We have adduced some evidence which tends to indicate that at least two saponins exist in false Bikhma, and it is possible that the method we used for separation afforded a mixture. It was our intention to have determined the ultimate composition of the saponin in combination with

lead, to which we have referred as a "viscid yellow compound," and to have examined the product yielded by the hydrolysis of the saponin, but we were unable to complete our research.

The results of the proximate analysis of the false Bikhma may be stated thus:—

Moisture ..	.. 6.23
Petroleum ether extract	.. 1.173
Acid ether extract	.. .123
Alkaline ether extract	.. .048
Chloroform extract	.. .064
Amylic alcohol extract	.. 1.58

We also append the results of an analysis of the specimen of *A. Palmatum* referred to above. Our 100 parts afforded the following results when examined by Dragendorff's method:

Petroleum ether extract	.. .040
Ether extract ..	.. .048
Absolute alcohol extract	.. .150
Water extract ..	.. 2.40

An alcoholic extract affords the following percentages:-

Petroleum ether extract	.. .946
Acid ether extract ..	.. .310
Alkaline ether extract	.. .371
Amylic alcohol extract	.. .976

The compositions of these extracts we were also unable to examine.

We may summarise our results by stating that the most important constituents of false

Bikhma are saponins, and as bearing on the identification of the plant which yields the drug, we would refer to Aitchison's "Notes on Products of Afghanistan and Persia," in which it is stated that the name *Bekh* is technically applied to the root-stocks of *Acanthophyllum Macrodon* and *Gypsophila Paniculata*. These are both used as soaps, and possibly false Bikhma may be derived from one of these plants.

Note on the presence of a Cholesterol in the roots of Hygrophila Spinosa.*

In the *Pharmacographia Indica*, one of us described the physical properties of a principle isolated from the roots of the *Hygrophila Spinosa*, which was not unlike a cholesterol. Subsequently, through the kindness of Dr. Dymock, we obtained a large supply of the roots, and were able to separate a sufficient amount of the material to admit of its thorough purification and ultimate composition being determined.

For ultimate analysis, the principle was crystalized from light petroleum ether, and the combustion made in an open tube in a current of oxygen. The tube had been in use some time and was in very good working order. The results obtained led to the following formula :—

* By C. J. H. Warden, M. D. and Chunilal Bose, M. B. Pharmacographia Indica, Index and Appendix, page 191.

			Calculated for $C_{26}H_{44}O$.	Found.
C_{26}	..	312	83.86	83.80
H_{44}	..	44	11.82	12.02
O	..	16	4.32	4.18
		372	100.00	100.00

At 175°C. (uncor.) the cholesterol commenced to soften, and melted at 184° (uncor.) The fusing point would appear to be higher than that of any cholesterol hitherto isolated. We were unfortunately unable to determine the specific rotatory power.

In purifying the cholesterol, an alcoholic extract of the root was dried and exhausted with ether. The dry ether extract was treated with dilute sulphuric acid, and the insoluble residue taken up by ether. The ether extract was next boiled with aqueous caustic potash, the solution evaporated to dryness, and extracted with petroleum ether. The petroleum ether extract was boiled for some hours with alcoholic potash, the solution evaporated to dryness, and extracted with petroleum ether. The petroleum extract was of a yellow colour, and in order to decolourise it, it was dissolved in absolute alcohol, and the solution agitated with purified animal charcoal; this, however, failed to remove the whole of the colour, and the following experiment was adopted. The alcohol was evaporated off, the residue dissolved

in petroleum ether, and the solution agitated with proof spirit; by this means most of the colouring matter was removed. The cholesterol was finally several times crystalized from petroleum ether, and was obtained perfectly white. A benzoyl derivative was also prepared. Evaporated with a drop of nitric acid and the dry residue moistened with ammonia, an orange colour developed, but no change was induced by the addition of caustic potash. The violet reaction with ferric chloride and HCl applied as described by Forti was very marked. The sulphuric acid and chloroform reaction was conducted in a stoppered bottle; the chloroform layer at first became yellowish-brown, then blood-red, finally darkening to reddish-purple; the sulphuric acid and stratum was of a pink colour, and in some experiments fluoresced.

ANALYSES OF EAST INDIAN PLANTAINS.*

The samples represent the most commonly used varieties, viz: *Kantali, Champa and Chattim.*

Percentage of Pulp and Pericarp in ripe fruit.

Variety.	Pulp.	Pericarp.
Kantali	70.85	29.15
Champa	74.37	25.63
Chattim	86.02	13.98

Percentage Compostion of Pulp,

	Water.	Ash.	Alkalinity of Ash in terms of Normal KHO.	Cane Sugar.	Grape Sugar.	Total Sugar.	Gum.	Total Acidity of pulp in terms of normal NaHO.	Fat.	Total Nitrogen.	Albuminoids N × 6.28.	Non-nitrogenous extractive by difference.
Kantali	67.68	.77	7.09 c.c.	8.36	7.75	16.11	.48	3.90 c.c.	.053	.2	1.35	13.657
Champa	71.47	.97	8.08 c.c.	..	..	14.15	.401	7.87 c.c.	.135	.288	1.80	11.109
Chattim	73.32	.73	7.34 c.c.	10.37	7.41	17.78	.36	4.57 c.c.	.00	.24	1.50	6.31

**By C. L. Bose, M.B.—Pharmacographia Indica, Vol, III, pages 446 and 447,*

On the

Chemistry and Toxicology

of

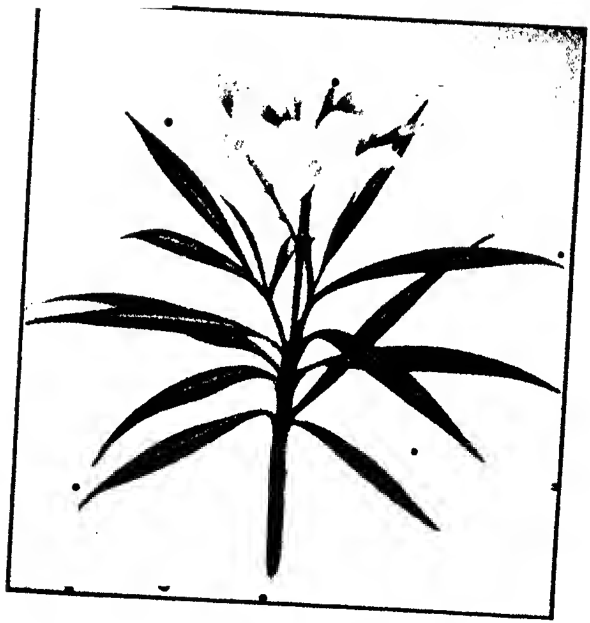
NERIUM ODORUM*

With a Description of a Newly-separated Principle.

Nerium Odorum, the sweet-scented oleander, known by the name of *Karabi* in this part of India and by *Kaner* in northern and western India, belongs to the Natural Order Apocynaceæ, the other important poisonous species belonging to this Order being Thevetia Neriifolia (Yellow oleander) and Cerbera Odollam. Holarrhena Antidysenterica (*Kurchi*), the bark of which is considered by Indian practitioners as a specific in chronic dystentery, also belongs to this Natural Order. *Karabi* grows wild almost all over India but is much cultivated in the gardens for the sake of its flowers, white

* Transactions of the Chemical Society, London, 1901.
Indian Medical Gazette, August and November, 1901.

Plate I.



Nerium Odorum

(Flowers and Leaves)

To face page 46.

Plate II.

Nerium Odorum.
(Flowers)

To face page 47.

and red, considered invaluable as an offering to the deity in the Tantric form of Hindu worship. The flowers are also offered to Shiva and other Hindu gods and goddesses.

Description.

It is an evergreen shrub yielding a milky juice. The plant is so common that a detailed description of its botanical characters is scarcely needed for its identification. The plant (Plates I & II) usually yields white or red flowers about $1\frac{1}{2}$ inches in diameter and sweet-scented, but a yellow variety has also been described by Honourary Surgeon E. A. Morris, Tranquevor, who found it growing near Seringapatam in the Mysore province. I have not seen any specimen of the yellow-flowered plant in this part of India. A short description of the leaves and roots with sketches is given below:-

Leaves.

"Linear-lanceolate; thickly coriaceous; accuminate; midrib stout; nerves numerous, slender, horizontal; petiole very short" (Plate I).

Root.

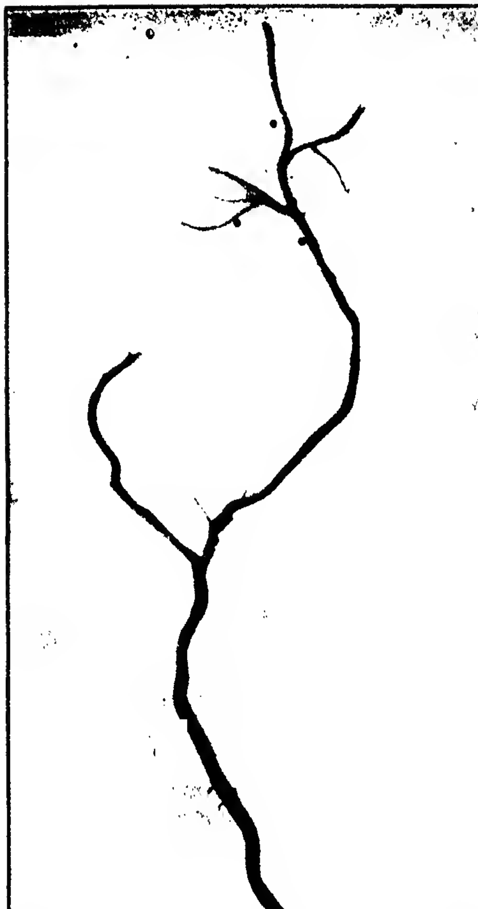
Crooked, branched, ending in fine rootlets (Plate III); externally pale yellowish-grey;

bark not very thick, soft, consisting of two layers, the outer one being pale yellowish-grey, the inner layer is of a greenish-yellow colour. The bark can be readily peeled off by the finger-nail exposing the white central woody portion. The bark possesses a slight bitter taste succeeded by a peculiar pricking sensation in the tongue attended with numbness which usually lasts for about half an hour. The sensation is similar to the one produced on the tongue by the ethereal extract obtained by Stas' process from the fruits of the yellow oleander. The Nerium root is distinguished from the yellow oleander root by the latter possessing a very thick succulent root-bark having no inner greenish-yellow layer. The root-bark of the yellow oleander, when scraped, yields a thick milky-white sticky fluid, absent in the Nerium root. When warmed with strong Hydrochloric acid, the root-bark of the yellow oleander turns blue (Warden's test), but no such colour is produced in the Nerium root-bark when similarly treated.

Microscopical characters of the root.

A transverse section of the root discloses wood-cells and vessels, abundantly traversed by medullary rays which consist of single rows of thick-walled parenchymatous cells. Drops and patches of a yellow and orange-coloured thick exudation are found deposited here and there in the woody portion of the root. The

Plate III.



Nerium Odorum.
(Root)

To face page 48.

Plate IV.

Nerium Odorum.

(Transverse section of the root)

To face page 49.

outer pale yellowish-grey layer of the root-bark consists of several layers of flattened cork-cells containing drops of a colourless fluid ; the inner greenish-yellow layer consists of parenchymatous tissue of narrow cells with patches of a yellowish colour and containing small dark-coloured nodular masses. There are numerous openings of vessels in the inner layer of the bark. The cambium layer consists of a few rows of greyish thin-walled cells. Starch cells are found scattered both in the wood and bark of the root.

In the specimens I examined, I could not detect any crystals of oxlalte of lime described as being present by Mr. H. G. Greenish in the Pharmaceutical Journal of April 23, 1881, page 873.

The *characteristic* microscopical appearance of a traverse section of the root consists in the presence of numerous medullary rays in the woody portion running from the centre to the circumference, in the presence of yellow and orange-coloured drops of thick fluid in the wood and yellowish patches in the inner layer of the bark, as well as in the arrangement of the cork-cells in the outer layer of the bark. These characters are well seen in the subjoined drawing (Plate IV) sketched by an artist-friend of mine from a specimen prepared and mounted by me.

MEDICINAL USES.

Very few preparations of the Hindu Materia Medica contain Nerium as one of their ingredients. There is, I find on enquiry, only one preparation called the *Mohabissesmara rasa* containing Nerium root in small quantity and which is administered internally for the cure of leprosy. For external application, an oil prepared by boiling the roots of Nerium Odorum and Plumbago Rosea, seeds of Embelia Ribes and cow's urine in sesamum oil is recommended by Sanskrit writers as a cure for eczema and other skin diseases. The fresh juice of the young leaves is described as a useful application in Ophthalmia attended with copious lachrymation. A paste made of Nerium roots with water is recommended by *Chakradatta* as a cure for chancrous ulceration on the penis.

We find it stated in the Pharmacographia Indica that the Mahomedan physicians describe it as a most powerful resolvent and attenuant, only to be used externally; internally, it acts as a poison upon men and animals. A decoction of the root is recommended to reduce swellings, and an oil prepared from the root-bark is recommended in skin diseases of a scaly nature and in leprosy.

Surgeon-Major C. W. Calthrope states that a poultice of the leaves fried in oil is applied to wounds to kill maggots.

The root of the white-flowered Nerium has an Indian reputation as being one of the best antidotes for snake-poison and there prevails a strong popular belief in the virtue of this root as a repellant of snakes. It is alleged that its presence in a room is sufficient to drive away snakes.

Toxicological Notes.

The plant has from very remote times been known in India to possess poisonous properties. It is one of the seven minor posions of the Hindu Materia Medica, the other six being *Opium, Abrus Precatorius seeds, Datura, Gloriosa Superba roots, milky juice of Calotropis Gigantea* and *Euphorbia Neriifolia*. One of the Sanskrit names of the plant is *Aswamaraka*, or destroyer of horses and "it would seem from this that the poisonous roots were used for destroying horses."

All parts of the plant are poisonous. Dr. Honigberger was of opinion that the wild hill-plant was more poisonous than the cultivated variety and he is supported in this opinion by M. Latour and Prof. E. Pelikan who found by careful analysis that the wild variety contained a larger quantity of the poisonous principle. In the hills and in western and southern India, the root is said to be commonly used by women

for suicidal purposes. The use of the Nerium root for suicidal purposes is, however, not common in Bengal; the fruits of the yellow oleander are more largely used for this purpose. During the fifteen years ending 1888, 14 cases of Nerium poisoning were referred to the Chemical Examiner, Bombay, and 11 to the Chemical Examiner, Madras; only two cases were dealt with by the Chemical Examiner, Bengal, during the same period.

In Bengal, the root of Nerium Odorum is used chiefly for the purpose of causing criminal abortion, it being applied locally and given internally for this purpose.

Dr. Watt mentions that the goat appears to be able to feed on the foliage of the plant with impunity, but it proves fatal to camels and other animals. The plant is said to be poisonous to insects also.

The employment of the root by ignorant persons for the cure of gonorrhœa and syphilis has been attended with fatal results.

The use of Nerium Odorum root for homicidal purposes is not common in Bengal. It may appear strange that a plant which possesses such marked toxic properties is not largely utilised to serve the purposes of the poisoner. The fact is that its toxic properties are not widely known; most people consider it and the *Yellow Oleander* to be quite harmless, and as such, largely grow them in compounds and gardens.

CASES.

(1) *Suicidal*—The first recorded case of *Nerium* poisoning was reported in 1843 by Dr. Greig of Sitapore. It occurred on the 9th March, 1840. A man, aged about 50, took some *Nerium* root mixed with mustard oil, to destroy himself on account of a domestic quarrel. He was brought to the hospital about an hour and a half after the ingestion of the poison in an apparently insensible condition. The principal symptoms noticed in the case were—vomiting, preternaturally slow but regular pulse and insensibility.

The man was making favourable progress, when, after making slight exertion, he suddenly died probably from heart-failure, about 24 hours after he had taken the poison. He never complained of any pain in the abdomen.

At the *post-mortem* examination, small patches of congestion with red points were discovered near both the pyloric and cardiac ends of the stomach posteriorly; there were also two slight abrasions on the mucous membrane of the stomach. The cavities of the heart, particularly the ventricles, were filled with black fluid blood. Other organs were found healthy.

(2) *Suicidal*—Dr. Broughton, Civil Surgeon of Kolhapore in the Bombay Presidency, reported a case of Nerium poisoning, which was treated in the civil hospital at Kolhapore in August, 1858. The history pointed to an attempt at

suicide by swallowing a little more than an ounce of the expressed juice of Nerium (it is not stated whether the juice was expressed from the leaves or bark). He fell senseless within five minutes and was removed to the hospital. The following symptoms were noticed in the hospital:—face and eyes flushed, head hot and perspiring, breathing stertorous, foaming at the mouth, violent spasmodic contractions of the muscles of the entire body but more marked in the superior than in the inferior extremeties and also more developed on the left than on the right side. During the intervals of the spasms, the patient lay flat upon his back. There were insensibility, quick thready pulse, involuntary passing of greenish watery stools and collapse. After 36 hours, reaction was established, spasms ceased, but insensibility remained as before. He regained his speech and sense after 48 hours. The man recovered.

(3) *Accidental*—In the British and Foreign Medical and Chirurgical Review, 1860, Maschka related the case of a boy who ate two handfuls (?) of Nerium oleander. The effects commenced in 10 minutes; the child was uneasy and vomited. In six hours, a sleepy condition came on; the face was pale, the skin cold, the pupils contracted and the pulse slow and regular. After the sickness, the boy woke up, but again fell asleep, and this occurred frequently; coffee was given, which appeared to do good. The pulse was intermittent. On the following day,

the child was still ill, with an intermittent pulse frequent vomiting, feebleness, sleeplessness and dilatation of the pupil ; there was no diarrhœa. (Blythe on Poisons, p. 435).

(4) *Accidental*—Dr. Dwarkanath Mukerjee reported a case of Nerium poisoning, which was admitted and treated in the Calcutta Medical College Hospital on the 3rd August, 1866. The history pointed to the patient's taking about 180 grains of the root of white-flowered Nerium for the cure of chancre and syphilitic eruptions on the skin. The following symptoms were reported to have developed in the case :—

Giddiness ; general uneasy sensation ; considerable restlessness ; vomiting ; tetanic convulsions ; lock-jaw ; constant muscular twitchings all over the body ; rigidity of the voluntary muscles. The patient never lost consciousness and his mind quite clear throughout. The man made a good recovery in 24 hours under treatment.

(5) *Accidental*—In a case of Nerium poisoning reported by Dr. Kamikshyanath Acharya in 1866, a boy was given powdered bark of the root of Nerium Odorum as a remedy for intermittent fever from which he was suffering. Lock-jaw and tetanic convulsions were noticed in this case. The boy recovered under treatment.

(6) *Accidental*—Dr. Cleghorn in 1868 reported two fatal cases of Nerium poisoning which occurred at Harriparah in the District

of Murshidabad under the following circumstances :—

Three persons came to the house of a prostitute who gave them in milk the powdered root and bark of *Nerium Odorum* as a cure for gonorrhœa. Soon after they became sick, vomited, complained of pain in the abdomen, writhed about on the floor and became sleepy. The woman got frightened at the condition of these men and bolted from the house. The bodies of two of the men were afterwards recovered from her house and Dr. Cleghorn made the *post-mortem* examination on them. The fate of the third person was not known.

In one case, he found engorgement of venous sinuses of the brain ; abundant puncta sanguinea ; vessels on the exterior surface of the heart congested ; right ventricle distended with dark fluid blood ; congestion of vessels in the stomach at its posterior surface near the greater curvature with well-defined patches of congestion near its pyloric and cardiac ends ; mucous membrane of the intestine throughout of a dark colour with very distinct large veins ; a large patch of congestion in the duodenum ; spots of congestion scattered in the jejunum and ileum ; large patches of congestion in the sigmoid flexure ; large vessels of the liver congested ; the kidneys were intensely congested.

In the other case, the brain, the lungs, the intestines and the kidneys were reported to be healthy. There were two ounces of serum in the

pericardial sac; both the ventricles of the heart were filled with fluid blood; the stomach bore well-marked specks of stellate congestion; there were also spots of congestion on the anterior and posterior surfaces of the peritoneal coat of the stomach, covering its cardiac end.

(7) *Suicidal* (?) —Dr. Murray reported a case of *Nerium* poisoning in the September number of the Indian Medical Gazette, 1877. An Indian male, aged about 35, took a strained watery decoction of four ounces of the Nerium root. Soon after taking the poison, he was attacked with vomiting and cramps, and in two or three hours, he baceme insensible. The following symptoms were noticed 8 hours after the ingestion of the poison:—Insensibility; skin cold and clammy; pulse weak and thready; muscles of the jaws stiff; eyes turned up, whites only visible; hands pretty open but fingers rigid, thumbs turned inwards; frequent convulsive spasms. The end of the case is not known as the friends of the patient removed him from the hospital while he was still in an insensible condition. The motive for the administration of the poison is not mentioned in Lyon's book on Medical Jurisprudence from which the above notes have been compiled.

(8) *Accidental*—In December 1897, a case of poisoning by *Nerium* root was successfully treated in the Calcutta Medical College Hospital. I am indebted to Assistant Surgeon Satyasaran

Chakrabarti, Registrar, Medical College Hospital, for supplying me with the notes of the case.

A man aged 35 years, by profession a *Palwan* (wrestler), took a quantity of *Nerium* bark for the relief of cough. On admission, he was found unconscious, with small extremely feeble and slow pulse—30 per minute, respirations quick, occasional convulsions, putting out the tongue, and inability to speak. Strychnine and ether were injected hypodermically. Pulse was better half an hour after the injection, 92 per minute; respirations 52 per minute, 30 grains of zinc sulphate were introduced through a nasal tube, as the stomach-pump could not be introduced by the mouth owing to violent convulsions, after which there was nausea but no actual vomiting. Two hours after sdmission, the patient was found perspiring, getting spasms all over his body, laboured respiration (44 per minute), pulse irregular and small (about 90 per minute), heart-sounds irregular. About 5 hours after admission, 14 ozs. of urine were drawn off by a catheter. The urine was free from albumen. There was an irregular rise and fall in the pulse-rate ranging between 35 and 60 per minute, and at times becoming intermittent for several hours. About 12 hours after admission, the patient's condition grew worse, had difficulty of breathing, extremities cold, unconscious, getting spasms, pulse feeble and slow. Ether was hypodermically injected and hot bottles applied to extremities. He

continued in this condition for nearly 6 hours after which he recovered gradually, the pulse rose to 80 and the respirations came down to 20. His consciousness returned. He was discharged cured on the 4th day after admission.

(9) *Accidental*—In November 1898, two cases of *Nerium* poisoning were treated in the Calcutta Polce Hospital under Surgeon-Major J. B. Gibbons, I.M.S., and were reported in the April number of the Indian Medical Gazette, 1899, by Assistant Surgeon Kalimohan Sen who was in charge of the cases.

The cases were admitted into the Hospital on the 24th November 1898, at about 10 A.M. The history pointed to each having taken a cupful of a strong decoction of the *Nerium* root at about 7 A.M., for the cure of pain in the loins (rheumatism ?) from which both of them had been suffering:—

(A) Mahomedan male, aged about 50. Vomited several times before and after coming to the Hospital. Vomited matter consisted of yellowish frothy fluid. At the time of admission, he was quite conscions and able to speak and swallow; complained of no pain in the stomach; pulse small, soft, slow (about 60 per minute) but regular; respirations normal; eyes congested; *pupils unequal, the right one being contracted.*

Two hours after admission, drowsiness and *twitchings of the muscles of the hands* were noticed. An hour after, *spasms* were noticed, *most marked*

in the upper extremeties and face but slight in the legs. There was no lock-jaw but dysphagia was a marked symptom and the patient was unable to speak, although he appeared to understand when spoken to and frequently smiled vacantly. Respirations were hurried and the *pulse slow and small,* and 50 per minute.

Four hours after admission, he began to get *tonic convulsions of all the muscles of the body, specially of the upper extremities*; no lock-jaw. An hour after, the whole body was found rigid, and there were lock-jaw, twitchings of the fingers and bending of the neck towards the right; froth coming out from the mouth. The pulse was frequent (about 100 per minute) and the respirations hurried (about 70 per minute).

About 12 hours after admission, the upper extremities were found still rigid but the lower extremities were flaccid; breathing was hurried and stertorous and the pulse was frequent and small.

Rigidity of the muscles began to disappear gradually but the general condition of the patient became worse. The pulse began to fail, the breathing continued stertorous and the conjunctival reflex was lost. The patient died about 26 hours after the ingestion of the poison.

Dr. Gibbons held a *post-mortem* examination on the body about four hours after death and recorded the following conditions:—

"Rigor mortis well-marked; body still warm to the touch. Right pupil a little smaller

than the left. Thumbs resting against fingers. *Lungs*, adherent behind and very congested with fluid blood. *Heart*, right side full with blood, left side nearly empty; spots of sub-endocardial hæmorrhage on front wall and towards apex on both walls. *Liver, Spleen* and *Kidneys* congested. *Stomach*-contents, about 1½ ozs. of greenish-yellow fluid and much mucus, no smell; stomach in folds with tops congested; mucous membrane congested, specially along the lesser curvature. *Small intestine*, contents, yellow mucus, slight congestion of upper part of duodenum and a few scattered spots of congestion. *Large intestine* healthy, contained liquid fæces. *Brain*, healthy. *Trachea*, congested and frothy liquid in the bronchi.

(B) Mahomedan male, about 28 years of age. The symptoms in this case were similar to those in the first case, except that they were apparently of a comparatively mild nature; there were vomiting, *slow and feeble pulse*, hurried respirations, *twitchings of the muscle of the upper extremities*, which, however, developed about 12 hours after the ingestion of the poison as against five hours in the first case; *unequal dilatation of the pupils*, bending of the head towards the right, *general tonic convulsions of the whole body*, opisthotonous; *lock-jaw*. A movement of the head from side to side was noticed and there was a slight rise of temperature

on the second day of poisoning. Under treatment, he began to improve steadily, but remained in a debilitated condition for about three weeks, after which he was discharged from the Hospital cured.

The treatment in both the cases consisted in giving emetics and alcoholic and diffusible stimulants, mustard plasters over the heart and hypodermic injections of sulphuric ether.

The viscera of the deceased and the vomited matter of both the persons were sent to the Chemical Examiner, Bengal, for analysis. A *narcotico-irritant* principle was detected both in the viscera and in the vomited matter, which produced vomiting, weakness of the heart, general uneasiness and drowsiness in a cat but not twitchings or convulsions. The poisonous principle could not be identified.

From the study of the above-mentioned cases, and from the action of the poison on cats (vide Chemical Notes), the *Symptoms* and the *post-mortem appearances* one may expect to find in a case of *Nerium* poisoning, may be generalised as follows :—

Symptoms.—Vomiting ; general uneasiness and restlessness ; frothy salivation ; slow and feeble condition of the pulse ; hurried respiration, sometimes stertorous ; twitchings of the

muscles of the extremeties, specially marked in the upper ones and more developed on one side than on the other ; rigidity of the voluntary muscles ; tetanic spasms of the whole body, sometimes opisthotonous, frequently lock-jaw, drowsiness passing into insensibility ; collapse. Diarrhœa usually absent.

Post-mortem appearances.—Patches of congestion in the stomach and upper portion of the small intestine ; congestion of the liver, lungs and kidneys ; engorgement of the general venous system ; both sides of the heart full of blood.

Chemical Notes.

In isolating the poisonous principles from the root of the *Nerium Odorum*, I submitted the drug to two altogether separate methods of analysis. One of these methods was that adopted by Mr. Greenish in the analysis of this plant and described by him in the *Pharmaceutical Journal*, 1881, page 873, with certain important modifications which will be described later on ; the other was the recognised method of plant-analysis formulated by Dragendorff. My object in doing it both ways was to check the results of one method by those of the other. I am glad that I adopted this plan, as it enabled me to detect a poisonous principle in the plant, which had hitherto remained undiscovered.

Mr. Greenish in his valuable paper on the chemical composition of *Nerium Odorum* described two poisonous principles only, which he could isolate from the root-bark of this plant. I have, however, been able to detect *three different poisonous principles* in the root of *Nerium Odorum*. One is *readily soluble in cold water* and is identical with the Neriodorein of Mr. Greenish (which, as I shall show later on, is not a new organic principle but only a Saponin). The second principle is insoluble in cold water, but *soluble in boiling water* and *chloroform* and *very slightly soluble in ether*; this is identical with the other principle Neriodorin of Mr. Greenish. The third principle is *insoluble in cold water as well as in boiling water, but very readily soluble in ether*; this principle, I believe, has for the first time been brought to light and I have accordingly called it by the name of *Karabin* (*Karabi* being the Bengali name of the plant) in my paper.

I shall first briefly describe my results as obtained by Dragendorff's plan of analysis.

The roots were carefully cleaned of all dirt and mud and left exposed to air to dry, first, at the ordinary temperature of the laboratory (between 70° and 80°F.), and then in a warm place (about 100°F.). It was next powdered and passed through a sieve. The powder was then bottled up for future use.

Moisture.—2 grms. of the powdered root were put in a tared platinum capsule and placed in an air-bath at first at 100°C. for 3 hours and then at 110°C. till it ceased to lose weight. It was next placed under a dessicator and weighed when cool. Moisture was calculated to be 13.14 per cent.

Ash.—The moisture-free substance was next ignited; the usual odour of the burning of vegetable matter was noticed. The ash calculated on the moisture-free root was 6.27 per cent.

The ash was of a brownish colour and strongly alkaline in reaction. It was partly soluble in cold water. The *soluble ash* contained carbonates, sulphates and chlorides of Potassium and Sodium. No phosphates or lime salts were detected in it. The *insoluble ash* consisted chiefly of carbonates of lime and Iron, with gritty siliceous matter and traces of Aluminium, Magnesium and Copper salts.

Extracts.—20 grms. of the dried powdered root were successively treated with 200c.c. each of petroleum ether, ether, absolute alcohol and distilled water; the solventswere separated, evaporated to dryness and examined. The root gave the following percentages of the different extracts:—

(*a*) Petroleum ether extract ..	2.88	per cent
(*b*) Ether extract ..	1.38	Do.
(*c*) Absolute alcohol extract ..	2.40	Do.
(*d*) Aqueous extract (after deducting the weight of the ash)	5.81	Do.

(*a*) *Petroleum ether extract*—A thick greenish-yellow viscid oily substance which partially solidified on exposure to air at the ordinary temperature. Warm absolute alcohol dissolves it (with the exception of a few brown flocks) forming a yellow solution, which becomes turbid on cooling, depositing whitish flakes. The alcoholic solution has a nauseating but not bitter taste. The whitish flakes examined under the microscope were found to consist of fine curved needle-like structures, some branched. The alcoholic solution on spontaneous evaporation deposited drops of a thick yellow oil, which readily saponified with alcoholic potash on being warmed. The soap was taken up with water and treated with diluted hydrochloric acid, when a copious deposit was thrown down. It was filtered and the filtrate tested for glycerine with negative results. No alkaloid was obtained from the petroleum ether extract.

(*b*) *Ether extract*—Is of a pale greenish-yellow colour, having a pleasant aromatic odour. Under the microscope, a large number of narrow oblong plates was discovered in it; the ethereal extract was first treated with cold water, which practically dissolved nothing, although it showed a slight acid reaction; the substance was next treated with absolute alcohol, which dissolved a part of it, forming a clear yellow solution. It was separated and evaporated to dryness,

when a brownish-yellow sticky residue was left.

This is the new principle, *Karabin*, referred to in the 2nd para. of the *Chemical Notes*; it possesses marked toxic properties. In its physiological action, it closely resembles the *Neriodorin* of Mr. Greenish but in its behaviour with certain solvents as well as in some of its chemical reactions, it is altogether different from either of the two principles (Neriodorein and Neriodorin) obtained by him from the root-bark of Nerium Odorum, as will be seen from the statement given below :—

(a) Behaviour with solvents.

Solvents.	Neriodorein.	Neriodorin.	Karabin (the newly-discovered principle.)
Water	Readily soluble.	Soluble in boiling water only.	*Insoluble* in cold and boiling water.
Absolute Alcohol	Slightly soluble.	Soluble.	Soluble.
Ether	*Insoluble.*	*Very slightly soluble.*	*Very readily soluble.*
Benzene	*Insoluble.*	*Insoluble.*	*Soluble.*

(b) Behaviour with chemical reagents.

Chemical reagents.	Neriodorein.	Neriodorin.	Karabin (the newly-discovered principle.)
Conc. H_2SO_4	Maroon-brown passing to violet. On exposure to the fumes of HNO_3 or Bromine, no change was noticed.	Yellowish-brown; on exposure to the fumes of HNO_3 or Br., it immediately changes to a beautiful mauve-voilet.	Light-brown; on exposure to the fumes of HNO_3 or Br., a faint violet-brown colour develops after sometime. The difference between it and the Neriodorin is very well seen when the two substances are tested side by side.
Conc. H_2SO_4 + KNO_3	No change.	Reddish-violet colour.	No reddish-violet colour.
Conc. HCl + heat.	No change.	Dissolves to a yellowish solution, no separation of flocks.	Partly becomes soluble forming a greenish-yellow solution with separation of flocks of a dark greenish-blue colour.
Fehling's solution + heat.	No reduction	Reduction.	No reduction.
Boiled for 3 hrs. with 2 per cent HCl, neutralised with KOH and then heated with Fehling's solution.	Reduction.	Reduction.	No reduction.

Physiological action of Karabin.

A minute quantity of Karabin was rubbed on the tip of the tongue; after a short time, a slight bitter taste was noticed attended with an acrid pricking sensation followed by numbness which lasted for about 15 minutes.

1st Experiment—$\frac{1}{2}$ grain of Karabin was dissolved in a few drops of rectified spirit and the solution diluted with about 2 drachms of distilled water; a copious separation of a yellow resin-like substance took place; the turbid watery solution was injected into the stomach of an adult healthy cat at 1-5 P.M.

1-10 P.M.—Constantly putting out its tongue and licking its lips as if to allay some unpleasant sensation; making frequent movement of the ears.

1-13 P.M.—Frothy saliva dribbling from the mouth; is uneasy; passed urine and a healthy stool.

1-15 P.M.—Vomited a large quantity of a yellowish-white frothy fluid; profusely salivating.

1-20 P.M.—Frequent ineffectual attempts at vomiting; moaning; great weakness in the limbs; falls down in an attempt to move; respirations so hurried that they could not be counted; passed a soft dark-coloured stool; is slightly drowsy.

1-37 P.M.—Marked spasms of the front and hind legs as well as of the muscles of the ab-

domen; constant tremors all over the body. more marked in the head and in the front legs; still retching; can not move or remain steady on account of the spasms which are not of a tetanic character; frothy saliva still dribbling from the mouth; pupils normal; is sleepy and dozing, appears to be in a state of intoxication and is extremely debilitated.

1-48 P.M.—Vomited a small quantity of whitish frothy fluid; is able to move slowly; gait tremulous and staggering.

2-15 P.M.—Is quietly sitting in a corner in a condition of stupor with its head hung between the forelegs, the muzzle almost touching the ground; now and then making a peculiar rocking movement of the head; appears insensible to all sounds and disturbances; breathing much quieter, but still shallow and quick; occasionally starts up as if from deep sleep but immediately returns to the condition of stupor.

3 P.M.—Same condition.

4 P.M.—Same condition.

The cat was found all right next morning at 10 A.M.

2nd Experiment.—An adult healthy cat was used; heart's beat 128 per minute.

.3 grain of *Karabin* was dissolved in a few drops of rectified spirit and the solution diluted with about 2 drachms of distilled water; the turbid solution was injected into the stomach of the cat at 12-40 P.M.

12-45 P.M.—Putting out its tongue and licking its lips as noticed in the first experiment; moving its head and frequently stiffening its ears.

12-50 P.M.—Heart's beat 120.

12-55 P.M.—Vomited a large quantity of whitish frothy fluid; profusely salivating; occasional spasms of the muscles of the back noticed.

1 P.M.—Passed a soft feculent stool; vomited a quantity of whitish frothy fluid.

1-8 P.M.—Passed a small stool; vomited again; heart's beat 120.

1-11 P.M.—Vomited again; still salivating; gait staggering; respiration hurried and irregular; spasmodic contractions of the tail and the legs.

1-23 P.M.—Vomited again, heart's beat 104.

1-55 P.M.—Is in a condition of stupor; breathing slow and long drawn; occasional starting.

2-30 P.M.—Heart's beat 102; respiration slow, 16 per minute; is still under deep narcosis; can be roused by a shake, but the animal immediately falls to sleep again.

3-30 P.M.—The cat is fully awake but rather dull; is sitting quietly; heart's beat 118.

4 P.M.—The cat appears to have perfectly recovered.

Neriodorin produces very similar physiological action which will be described later on.

The root was found to contain one per cent. of *Karabin*.

The ultimate analysis of *Karabin* by combustion gave the following results :—

C—63.4 per cent.
H—12.3 „
O—24.3 „

The formula deduced from the percentage composition of the substance is $C_{21}H_{49}O_6$.

The portion of the ethereal extract which was insoluble in absolute alcohol was found to consist of an acid *resin* and an *indifferent resin*.

(c) *Absolute alcohol extract*—A yellow varnish-like residue having no particular odour ; it was slightly soluble in water forming a clear yellow solution having an acid reaction. This solution had a very slight bitter and acrid taste, the portion which was insoluble in water was treated with water acidulated with a few drops of diluted sulphuric acid and agitated successively with petroleum ether, benzene and chloroform. The *petroleum ether extract* consisted of minute traces of a yellowish oily deposit. The *benzene extract* consisted of a small quantity of a pale, yellow coloured sticky deposit ; when rubbed on the tongue, it produced the characteristic pricking and numb sensation of *Karabin*. When treated with sulphuric acid and then exposed to nitric acid fumes, a very slight violet colour was developed after sometime. It was identified to be *Karabin*. It was soluble in ether and benzene but insoluble in boiling water. When treated with Conc. HCl, it became decomposed with the seperation of dark greenish-blue flocks.

The *chloroform extract* was of a yellowish colour, sticky and produced marked pricking and numbness of the tongue. Sulphuric acid with nitric acid vapours, *immediately* produced a mauve-violet colour. It was soluble in boiling water but insoluble in ether. It was identified to be the *Neriodorin* of Mr. Greenish.

The acid watery solution was next neutralized with carbonate of soda and agitated successively with petroleum ether, benzene and chloroform. The *petroleum ether extract* was practically *nil*. The *benzene extract* consisted of a very small quantity of a yellowish sticky substance which produced slight numbness of the tongue when rubbed on it. It had no appreciable bitter taste. The *chloroform extract* consisted of traces of a yellowish deposit; no bitter taste; no numbness produced when rubbed on the tongue.

The portion of the alcoholic extract which was insoluble in acidulated water was found to be insoluble in petroleum ether, ether and benzene. It was soluble in chloroform. It possessed slightly bitter taste and produced slight numbness of the tongue. .25 grain given to a healthy cat produced vomiting in 10 minutes, followed by salivation. No further symptoms were noticed.

(*d*) *Aqueous extract.* The aqueous extract was of a dark-brown colour, slightly bitter to the taste and acid in reaction. It contained tannic acid and a *saponin*-like principle. No

pectin was detected in it. 3 grains of the extract were given to a cat. The animal vomited once after half an hour, there was slight salivation; no further symptoms.

I shall now describe the results of analysis obtained by adopting Mr. Greenish's method with certain modifications.

About 100 grms. of the powdered root were thoroughly exhausted with alcohol (80 per cent). The alcoholic solution was evaporated to a small bulk, when a quantity of dark-brown oily matter separated. On the addition of water to the concentrated alcoholic solution, a large quantity of a brown sticky resinous mass separated from a yellowish turbid liquid, which was acidulated with a few drops of diluted sulphuric acid and agitated successively with petroleum ether, ether, and chloroform. After agitation with *chloroform*, when the two layers separated, a small quantity of brown oily-looking globules was seen floating between the two layers. The oily-looking drops were separately collected and washed with ether and chloroform in both of which they were insoluble. The aqueous solution was then neutralized with carbonate of soda and agitated with chloroform.

The brown sticky, resinous mass which separated on the addition of water to the concentrated alcoholic solution of the drug was treated with petroleum ether, which on evaporation deposited a large quantity of a thick brownish oil, having no particular odour

and possessing a nauseous but not bitter taste. A search was made for alkaloids with negative results.

Acid petroleum ether extract—It deposited only traces of a light greenish-yellow oily substance.

Acid ether extract—It consisted of a small quantity of a brownish-yellow sticky residue possessing slight bitter taste: it produced a marked acrid and pricking sensation when rubbed on the tongue followed by numbness. When treated with strong sulphuric acid and then with nitric acid vapours, it slowly developed a reddish-violet colour which led to the supposition that it was slightly contaminated with *Neriodorin* (which is slightly soluble in ether). It was accordingly pruified by being repeatedly boiled with water (Neriodorin being soluble in boiling water). The purified extract was of a brownish-yellow colour, sticky, and satisfied all the tests for *Karabin* described before. One of the modifications made in Mr. Greenish's method of analysis referred to before, consisted in using ether as one of the solvents which took up a portion of the newly-discovered principle, *Karabin*; the remaining portion was recovered also by means of ether from the alcoholic residue after it had been extracted with acidulated water to be described hereafter.

Oily-looking globules—These separated between the chloroform and aqueous layers and

were thoroughly washed with ether and chloroform in which they remained insoluble. They very readily dissolved in cold water, forming a pale-yellow solution of neutral reaction. The substance was insoluble in carbon disulphide, benzene and amyl alcohol. Its aqueous solution frothed considerably when agitated, which at once suggested its being a variety of *saponin*. The watery solution on evaporation left a brownish-white residue, possessing a slightly bitter taste, followed by a slight tingling and numbness of the tongue which lasted only for a short time. The substance gave the following reactions with the various reagents—

Conc. H_2SO_4—A Maroon-brown colour passing to violet; on the addition of Bichromate of Potassium, it turned green after a short time.

Conc. HNO_3—Almost colourless solution, turning yellow on the addition of Potassium Bichromate.

Dilute NH_4OH—Dissolves readily, forming a pale-yellow solution which froths much on agitation; on neutralising it with acetic acid, a turbidity was produced.

Dilute KOH—the same as NH_4OH.

Tannic acid—a white precipitate.

Basic acetate of lead—a white precipitate.

Fe_2Cl_6—a turbidity, which disappeared on heating and the solution turned brown.

Nessler's reagent—Yellow colour changing to greenish on drying.

By itself, it did not reduce Fehling's solution as stated by Mr. Greenish but when boiled for three hours with two per cent. hydrochloric acid, it reduced Fehling's solution which was proof of its being a glucoside. In its chemical characters, it bears a strong resemblance to the saponin obtained from *Bikhma* by the late Dr. Warden and the writer (Pharmaceutical Journal, 1892, p. 302).

It will thus be seen that this principle which has been named *Neriodorein* by Mr. Greenish is only a variety of *saponin*. The characters of a saponin as described by Blythe in his book on Poisons, namely, that it is a white, amorphous, powder, insoluble in ether, readily soluble in water, which froths a good deal on agitation, and precipitating with tannic acid, were with no exception found to be present in the *Neriodorein* of Mr. Greenish. As the toxic properties of saponin are well known, they were not investigated in the sample obtained from *Nerium Odorum*.

The acid chloroform extract—It is a bright shining golden-yellow deposit not easily reduced to powder, having a bitter taste; when rubbed on the tongue, it produces an acrid pricking sensation followed by numbness which lasts for a short time only. It is insoluble in cold water, in petroleum ether, in benzene and in carbon disulphide, very slightly soluble in ether but

soluble in boiling water. Conc. sulphuric acid dissolves it forming a yellowish-brown solution which immediately turns to a beautiful mauve-violet on exposure to the vapours of nitric acid or bromine (*cf. Karabin*). When heated with concentrated hydrochloric acid, it formed a greenish-yellow solution without the separation of dark greenish-blue flocks (*cf. Karabin*). With sulphuric acid and nitrate of potassium, a reddish-violet colour was developed (*cf. Karabin*). It was readily soluble in alcohol from which a copious precipitate of a yellow resin-like substance took place on the addition of water. In this character, it resembles *Karabin*. This is the Neriodorin of Mr. Greenish.

Mr. Greenish heated *Neriodorin* with dilute hydrochloric acid in a sealed tube and found that it was broken up into a glucose which reduced Fehling's solution and he suggested that it was a glucoside. I have, however, found a solution of *Neriodorin* in hot water by itself reducing Fehling's solution and that heating with dilute hydrochloric acid does not increase its reducing properties. Moreover, the behaviour of the alcoholic solution of Neriodorin on the addition of water would point to its being a resin and not a glucoside. The same remarks apply also to *Karabin* which by itself does not reduce Fehling's solution nor is broken up into a glucose when boiled for hours with diluted hydrochloric acid. Neither of the two principles contains nitrogen.

2 grains of *Neriodorin* were dissolved in a few drops of alcohol to which about 2 drachms of distilled water were added ; a copious separation of yellow resin-like substance took place as described before. This was injected into the stomach of a healthy adult cat at 11-50 A.M.

Soon after, the animal began to constantly put out its tongue and lick its lips ; a profuse quantity of frothy saliva commenced to dribble from the mouth and the animal became restless. Frequent movement of the ears was noticed.

11-55 A.M.—Vomited a copious quantity of yellowish frothy fluid ; is very ill and restless ; moaning and retching.

11-57 A.M.—Twitchings and great weakness in the hind legs ; in an attempt to move, it fell down on one side ; breathing hurried.

12 noon.—Tremors and twitchings noticed over the whole body : is still retching ; is quite dull, almost in stupor ; frequent spasms of the muscles of the extremities.

12-6 P.M.—The animal fell on its side, had marked tetanic convulsions and died.

Post-mortem examination held about an hour after death.

Rigor mortis absent ; pupils widely dilated; mouth half open, tongue portruding out and bluish at the tip and edges.

Liver congested.

Kidneys congested.

Stomach of a uniform pink colour ; rugæ prominent ; it contained a small quantity of colourless mucus and a few worms.

Duodenum :—Patches of congestion.

Jejunum :—Do. (But fewer patches than in duodenum).

Ileum :—No congestion ; contained soft dark-green fæcal matter.

Large intestine :—Healthy ; contained soft dark-green fæces.

Lungs :—No congestion noticed.

Spleen :— Do.

Heart :—Right heart full of dark clotted blood ; left heart contained fluid blood only.

The venous system was found full.

Brain and spinal cord not examined.

2nd Experiment :—$\frac{1}{4}$ grain of *Neriodorin* was given to a healthy adult cat.

About 10 minutes after, the animal commenced putting out its tongue and licking its lips and moving its ears. There were frothy salivation and slight restlessness. After half an hour, it vomited a large quantity of undigested food. No tremors or spasms noticed ; the animal recovered.

The acidulated solution of the alcoholic extract after separation of the chloroform was neutralised with carbonate of soda, when a slight whitish precipitate was thrown down. It was agitated with ether which dissolved the precipitate. The ethereal solution on spontaneous

evaporation left a very small quantity of a white deposit, which was found to consist of needle-shaped crystals under the microscope. This substance when rubbed on the tongue had no bitter taste and did not produce any tingling or numbness. *It was dissolved in a few drops* of acetic acid, dried on water-bath and taken up with a few drops of distilled water, and the solution was tested with the following reagents:—

Mayer's reagent—Whitish precipitate.

Picric acid—Yellow precipitate consisting of irregular six-sided plates, like certain forms of uric acid crystals.

Potash-bismuth iodide—Brownish flocculent precipitate.

Gold chloride—Yellowish precipitate.

Platinic chloride—Yellowish precipitate.

Caustic potash—White precipitate.

Ferrocyanide of potassium—Whitish precipitate.

The substance, therefore, possesses the characters of an alkaloid; but the quantity obtained was so small that further investigations into its chemical composition and physiological action could not be proceeded with.

The dark brown residue of the alchoholic extract, after the treatment with the various solvents described before, was still found to possess a slight bitter taste, and when rubbed on the tongue, produced a mild acrid sensation and numbness. Half a grain of this substance

was given to a healthy adult cat; the animal suffered from frothy salivation, vomiting and restlessness. The animal also exhibited the peculiar symptoms of movements of the ear and putting out the tongue and licking its lips as seen with *Neriodorin* and *Karabin*. No spasms, twitchings or tremors were seen. The animal recovered within an hour.

The above described action of the alcoholic residue on the animal suggested that it still contained some *Karabin* or *Neriodorin*, presumably the former, as it is insoluble in water and could not have been taken up in any quantity by acidulated water from the alcoholic extract of the drug, but probably only that portion was removed by ether, which remained in suspension in the acidulated watery solution. The residue was accordingly dried on a water-bath and then over sulphuric acid and treated with ether, which dissolved a portion of it and left on evaporation, a moderate quantity of a brownish-yellow sticky, residue, which gave all the reactions of *Karabin*. The alcoholic residue after separation of the ether was agitated with chloroform, which dissolved a small portion of it and on evaporation left a dark-brownish residue, which was found to contain traces of *Neriodorin*.

Chemical composition of the leaves.—I have stated before that all parts of the plant possess toxic properties. Laukowsky, Schmiedeberg and others analysed the leaves of *Nerium*

Odorum. The former separated two poisonous principles which he considered to be alkaloids and which he named Oleandrine and Pseudocurarine. Schmiedeberg in 1883 separated two other principles besides *Oleandrine*, all of which he considered to be glucosides; he called the other two glucosides as *Neriine* and *Neriantine.* In 1890, Pieszczek separated *Neriine* of Schmiedeberg from the bark of Nerium Odorum; he found that when a portion of Neriine was dissolved in strong sulphuric acid and then exposed to the vapour of Bromine, a splendid violet-purple colour was produced. It, therefore, appears that the *Neriine* of Schmiedeberg is no other substance than the *Neriodorin* of Mr. Greenish.

Separation and identification of the poison in viscera &c.—From the study of the chemical characters of *Neriodorin* and *Karabin* and their behaviour with different solvents, the following directions may be laid down for the extraction of these poisonous principles from the viscera in a case of *Nerium Odorum* poisoning. The absolute alcoholic extract obtained by Stas' process should be treated with water acidulated with a few drops of diluted sulphuric acid and then agitated successively with ether and chloroform; the former will take up any *Karabin* and the latter *Neriodorin*, which may be identified, (1) by their producing the peculiar acrid pricking sensation on the tongue followed by

numbness; (2) by their behaviour with concentrated sulphuric acid and fumes of nitric acid, and with concentrated hydrochloric acid and heat; and (3) by the previously described toxic symptoms produced on animals.

Fatal dose for an adult human being:—Half a grain of *Karabin* nearly proved fatal to a cat. Two grains of *Neriodorin* killed a cat in 15 minutes. One grain of either of these substances may, therefore, be considered to be the fatal dose for an adult cat. From an analogy of the action of other vegetable poisons on cat and man, it will be within the mark if the fatal dose of either of these principles for man be fixed at five times that for a cat. In the case No. 4, about 180 grains of the root produced alarming symptoms but did not prove fatal. As the root contains about one per cent. of *Karabin* and probably an equal amount of *Neriodorin*, 250 grains (about ½ ounce) of the root (which would yield 5 grains of the two active principles) may be taken as the average fatal dose for an adult human being.

The *Neriodorein* of Mr. Greenish, which, as I have shown before, is a *saponin* only, may be neglected, as its toxic properties are of a much milder character than those of either *Karabin* or *Neriodorin*.

In conclusion, I wish to express my obligation to Captain C. H. Bedford, M.D., D.Sc., I.M.S., Chemical Examiner to the Government

of Bengal, for kindly supervising the whole paper, and to Assistant Surgeon Hira Lal Sinha, B.A., L.M.S., for much assistance in making the experiments.*

* This formed the subject of a thesis for which the writer was awarded the Coates' Memorial Prize for the year 1900 by the University of Calcutta.—*Editor.*

THE

TOXIC PRINCIPLES OF THE FRUITS

OF

LUFFA ÆGYPTIACA MILL,*

(BITTER VARIETY) TITA DHOONDOOL.

The plant belongs to the Natural Order Curcurbitaceæ and to the genus Luffa.

The edible variety of Luffa Ægyptiaca Mill (Beng. Dhoondool) is cultivated in many parts of Bengal, and the fruits are largely eaten by the poorer classes either simply boiled or made into a curry. The bitter variety is avoided as being poisonous; it can scarcely be distinguished from the edible plant except that its fruits are a shade darker in colour and their taste is extremely bitter.

Voigt in his *Catalogue of Plants* mentions the bitter variety of the plant as bitter in every part, and its fruits violently cathartic and emetic. I have, however, been unable to find on record a single case in which its use by mistake for the edible variety has been attended with toxic symptoms, and it does not appear that its properties have been properly inves-

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tigated. A case of poisoning by eating the bitter fruits came within my observation in November, 1903, which led me to investigate the chemistry of the fruit. A short history of the case is given below:

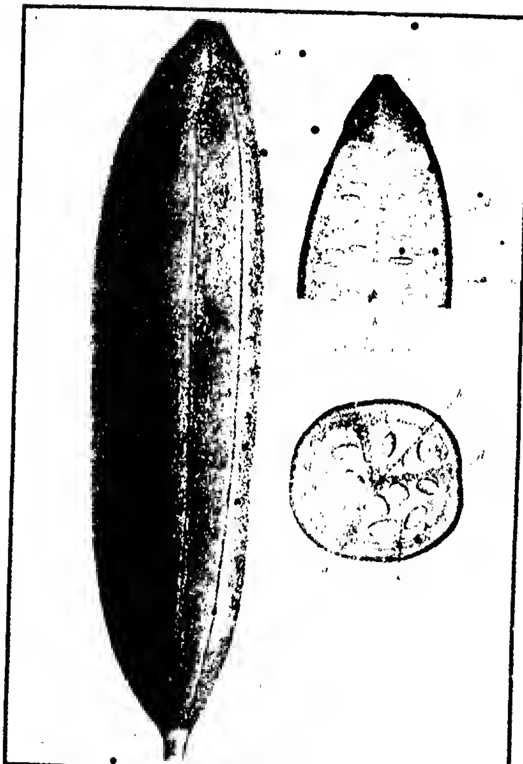
HISTORY.—On the 26th November, 1903, a dozen of these fruits were purchased by a neighbour of mine. On the following day, a curry was made of some of them with tamarind and other vegetables. This was served to two children both of whom complained that the taste of the curry was very bitter, so much so that one of the children spat it out immediately, but the other swallowed a small quantity; the latter, however, brought up her food in a few minutes. No further symptoms were observed in these two children.

D. S., my neighbour, an old man of 70, had on the next day a curry made of a couple of these fruits and took the whole quantity with his day-meal at about 1 p.m. He noticed that the taste of the curry was very bitter, but as he was particularly fond of bitter vegetables, he thought this fruit would be quite as harmless as the others. About 15 minutes after taking the meal, he complained of feeling uneasy and brought up a large quantity of food. This was soon followed by diarrhœa. Up till 8 p.m., he vomited twice and passed 8 copious watery stools containing undigested fragments of the fruit. When seen by me at 8 p.m., he was found to be very low, pulse very small,

feeble and rapid; skin cold and covered with clammy perspiration; there was extreme prostration; the patient was dull but quite conscious and answered questions rationally; he complained of pain in the abdomen and was getting cramps in the extremetics. His voice was very feeble. He was given diffusible stimulants, brandy, and small doses of Calomel at regular intervals. He passed three more stools during the night and two on the next morning. After this, the general condition of the patient and the character of the stools gradually improved and he made a slow recovery.

BOTANICAL CHARACTERS.—I obtained four of these fruits from the patient. The largest was 7 inches long and $1\frac{7}{8}$ inches broad at the thickest part. It was nearly straight, only slightly bent towards the extreme apex and had 10 slightly depressed linear furrows on the surface running lengthwise and almost equidistant from one another. The color was light-green, with greenish-yellow patches here and there in the centre. It was soft to the feel but here and there a few hard spots were noticed. On pricking the fruit, a frothy colourless juice oozed out. The operculum (Fig 1. a) was $1\frac{1}{8}''$ long and $1''$ broad at the base. Fig 1. gives about half the size and the shape of the fruit.. The smallest fruit was $4\frac{1}{4}''$ long and $1\frac{1}{8}''$ broad at the thickest part. It was quite straight and uniformly soft to the feel. The other two fruits differed only in size from the rest.

Figs. I. II. III.



Luffa Ægyptiaca

(Tita Dhoondool)

To face page 88.

On section, the interior exhibited a whitish soft spongy tissue in which white flat seeds were found embedded. There was a thick ring of white fibrous trabecula just underneath the skin extending throughout the whole length of the fruit (Figs. II & III, a). Three partitions of the same tissue ran in from the peripheral ring and met at the centre (Figs. II & III, b), thus dividing the space inside into three chambers of unequal dimensions, filled up with soft white spongy tissue in which seeds were embedded (Figs. II & III, c). The thickness of the trabecula was not uniform; it measured from $\frac{3}{8}''$ to $\frac{1}{8}''$ and was very rough to the feel. It darkened on exposure to air. The average thickness of the green skin was 1-16″ (Figs. II & III, d).

The younger fruits, on section, exhibited the same characters, with this difference that the trabecula was thinner and softer, the white spongy tissue more abundant and the seeds were smaller, softer and numerically less. The fruit was very bitter to the taste and had the ordinary smell of vegetable tissue.

CHEMICAL ANALYSIS.—The drug was submitted to the following two separate methods of analysis :—

1. ORDINARY ALKALOIDAL EXTRACTION METHOD.

2. DRAGENDROFF'S METHOD.

The fruits were cut into very thin slices and allowed to dry in the shade at the ordinary

temperature of the laboratory and then in the sun till they became quite crisp, when they were finely powdered. This powder was used in both the methods of analysis.

Moisture :—The sun-dried substance yielded 3.5 percent of *moisture*.

Ash :—The *ash* was 7.5 percent. It was partly soluble in water; the solution was alkaline and contained chlorides, sulphates and carbonates of the alkali metals. The insoluble portion of the ash was of a rusty colour and contained an appreciable quantity of iron.

1. *Ordinary alkaloidal extraction method.*

Ten grammes of the powder were macerated in rectified spirit for 6 days and filtered; the magma was again exhausted with rectified spirit for another two days and the filtrates were mixed together and evaporated to a thick consistence at a low temperature.

The alcoholic extract was of a dark yellowish green colour and very bitter. It was placed on a water-bath and then treated with warm water which took up most of the extract forming a reddish-brown turbid solution which became more turbid on cooling. The solution had an acid reaction.

The turbid aqueous solution was next agitated with ether when a quantity of a dark-brown flocculent substance separated, floating between the watery and the ethereal layers. The ethereal solution was separated and allowed to evaporate spontaneously to dryness; a

dark yellowish-green residue was left, having a faint aromatic odour (A).

The dark-brown flocculent substance was carefully separated, repeatedly washed with ether and dried by exposure to air. The residue was a brown amorphous deposit (B).

The aqueous solution was next rendered alkaline with carbonate of soda and agitated with ether. The ether, on evaporation, left traces of a whitish deposit which, under the microscope, was found to contain many dark-coloured needle-shaped crystals with amorphous matter and oil globules. The residue was treated with dilute hydrochloric acid, the acid solution evaporated to dryness and tested for alkaloids with negative results.

The ethereal residue (*A*) :—When examined under the microscope, it was found to consist of greenish drops of oil, much browinsh amorphous matter, a few stellate crystals and a large number of thin colourless crystalline plates which resembled cholesterin crystals. The residue was repeatedly washed with petroleum ether which removed much of the green colouring matter and a small quantity of whitish waxy substance devoid of any bitter taste. The portion of the residue insoluble in petroleum ether was of a greenish-yellow colour, crispy and was very bitter to the taste. It weighed .058 gramme. This was first treated with cold water in which it was apparently insoluble but the water gave a faint acid reaction. Boiling

water was next used when much of it became soluble forming a clear yellowish solution which, however, became turbid on cooling. The solution had a very bitter taste and strong acid reaction. The cold turbid solution was next agitated with ether which practically removed the turbidity. The ethereal solution on spontaneous evaporation left an almost colorless transparent varnish-like mass, having very bitter taste. It weighed ·02 gramme. It was re-dissolved in boiling water and the aqueous solution was tested with the following reagents :—

1. Tannic Acid ... a whitish precipitate.
2. Mayer's reagent ... no precipitate.
3. Ferric chloride ... slight green colouration.
4. Boiled with dilute sulphuric acid, neutralised, and then treated with Fehling's reagent —reduction.

Gramme .01 of this transparent varnish-like ethereal residue was dissolved in hot water and introduced into the stomach of a healthy adult cat at 12-15 p.m.

12-41 p.m. Vomited about an ounce of a yellowish frothy liquid.

12-51 p.m.—Vomited a similar stuff with two round worms.

1-20 p.m.—Respiration hurried ; the animal is restless, constantly changing its position ; voice very feeble.

1-40 p.m.—Had a healthy motion.

2-50 p.m.—Respiration very hurried ; seems to be much exhausted.

3-3 p.m.—Had another thin motion.

3-27 p.m.—Had another thin motion mixed with mucus and tinged with blood; there was much straining at defœcation; respiration still very hurried; the animal seems thirsty and is much exhausted.

The cat had two more loose motions mixed with blood and mucus during the night and vomited once more. At 2-30 p.m. on the next day, the animal once more vomited a small quantity of pale yellowish white liquid and *had a motion consisting of mucus and blood only.* It refused food for two days.

The dysenteric condition continued for two days and the animal remained very weak and exhausted. It made a slow recovery.

The portion of the ethereal residue (A) which was insoluble in boiling water consisted of a greenish sticky matter devoid of bitter taste. It was treated with cold ether which dissolved a portion of it only. The soluble portion on evaporation left a dark greenish sticky residue. It had an acid reaction and readily dissolved in weak caustic soda and was reprecipitated on the addition of acetic acid. It was found to possess the characters of an *acid resin.* The part insoluble in ether was of a dark-greenish colour and was also insoluble in boiling water. It was administered to an adult cat but the animal developed no toxic symptoms.

Dark-brown flocculent substance (*B*) :—It had no bitter taste and produced no poisonous symptoms when administered to a cat.

2. *Dragendroff's Method.*

Ten grammes of the powder were used.

(1) Petroleum ether extract ... 2 per cent.

It was of a yellowish-green colour, unctuous and contained a number of stellate crystals. Taste not bitter. It contained a fixed oil which thickened on drying. It contained no alkaloids.

(2) Ether extract ... 1.26 per cent.

The residue was of a greenish-yellow color, oily, had no bitter taste and contained no alkaloids.

(3) Absolute alcohol extract ... 0·9 per cent

It was a brownish-yellow, transparent, resinous-looking deposit. It formed a turbid solution with cold water which was bitter to the taste and acid in reaction. The turbidity cleared on boiling.

The extract was treated with warm ether, in which it was found practically insoluble; the ether took up only traces of an oily substance. It was next treated with chloroform in which it mostly dissolved, a small quantity of a reddish granular matter remaining insoluble. The chloroform solution was filtered. The filtrate on evaporation left a pale, dirty-yellow, transparent residue, extremely bitter to the taste, slightly soluble in cold water which showed a slight acid reaction. We shall call this residue C. It gave a white flocculent precipitate with

Tannic acid and a slight green colouration with Ferric chloride. It gave no precipitate with alkaloidal reagents.

The portion of the absolute alcohol extract, which was insoluble in chloroform, was repeatedly washed with chloroform, and then dissolved again in absolute alcohol and evaporated to dryness. It formed a brownish transparent varnish-like deposit; we shall call this residue D. It formed a turbid solution with cold water, having an acid reaction and a bitter taste; it became clear on boiling.

.02 gramme of D was administered to a healthy cat. No vomiting took place. About 4 hours after the administration of the drug, the animal had a soft healthy motion and then four more in the course of a few hours; these motions were soft and fæculent but contained much mucus and blood. The cat developed no further symptoms. The active principle D thus appears to be a brisk cathartic.

The chloroform residue C was next treated with boiling water with which it formed a turbid solution, a small quantity of dark-brown flocculent matter separating and settling at the bottom.

The dark-brown flocculent matter was carefully separated, well-washed with water and dried on a water-bath. It weighed ·010 gramme; I shall call this (a). It was dissolved in a few drops of rectified spitrit; a small quantity of water added and the turbid mixture

was introduced into the stomach of a cat at 12-48 p.m.

1-6 p.m.—Vomited about an ounce of a whitish frothy fluid.

1-8 p.m.—Vomited again about 2 or 3 drachms of a similar stuff.

1-17 p.m.—Vomited again a similar stuff.

1-30 p.m.—Vomited again a similar stuff.

2-5 p.m.—Vomited again and had a semi-solid motion.

No more motion or vomiting; no further symptoms.

The chloroform extract C when taken up with boiling water, formed a turbid solution which did not become clear on agitation with ether. The ether when separated and evaporated, left traces of a greenish deposit having no bitter taste. After the separation of the ether, the watery solution was evaporated to dryness on water-bath. The residue was brownish, transparent and varnish-like and had a very bitter taste, and I shall call it (b).

.016 gramme of this residue was dissolved in a few drops of rectified spirit, a small quantity of water added to it and the fluid was introduced into the stomach of a healthy adult cat at 12-22 p.m.

12-27 p.m.—Vomited a thin brownish frothy fluid (about 1 oz.); frothy saliva escaping from the mouth.

12-31 p.m.—Vomited again a similar stuff; much salivation.

12-37 p.m.—Vomited again a whitish frothy fluid.

12-42 p.m.—Vomited again a similar stuff.

12-48 p.m.—Had a healthy motion.

12-50 p.m.—Vomited again a similar whitish frothy fluid: breathing hurried; is dull, voice almost inaudible.

12-56 p.m.—Vomited again.

1-7 p.m.—Vomited again.

1-30 p.m.—General condition much the same; respiration hurried and irregular; voice still inaudible; is much exhausted; pupils normal.

1-50 p.m.—Had a copious thin motion mixed with mucus.

2-7 p.m.—Vomited about ½ ounce of a pinkish frothy fluid.

3 p.m.—Vomited a small quantity of pinkish frothy liquid.

4 p.m.—No more vomiting or purging; the animal is very weak and dull.

The cat remained very weak on the next day and refused food; it slowly recovered.

It will thus be seen that these residues (a) and (b) are evidently one and the same substance; they possessed marked irritant action on the stomach producing severe vomiting in the cats; they differed from the ethereal residue (A) obtained by the ordinary alkaloidal extraction method in causing only slight irritation of the lower bowels.

(4) Aqueous extract ... 1.68 per cent.

The dried extract was brownish-yellow and transparent. It had no bitter taste. It was found to contain tannin.

.15 gramme was dissolved in a small quantity of water and introduced into the stomach of a healthy cat. The animal developed no toxic symptoms.

CONCLUSION :—It will be seen that more satisfactory results were obtained by Dragendroff's method of analysis than by the ordinary alkaloidal extraction method. By Dragendroff's method, we could separate two distinct toxic principles from the fruit, viz., (1) a severe *emetic* and (2) a brisk *cathartic*. The ethereal residue (A) obtained in the ordinary alkaloidal extraction process appears to be a mixture of these two principles, as it produced both vomiting and purging when administered to a cat. The residue left by the evaporation of the absolute alcohol extract in the Dragendroff's method of analysis also contained these two principles, one of which (C) was soluble in chloroform and the other (D) insoluble in that reagent. (C) in both its divisions (a) and (b), which are probably one and the same substance, produced severe vomiting in the cats but it was only slightly irritant to the lower bowels. (D), however, seemed to possess no emetic properties, at least in the dose (.025 gramme) in which it was administetered to the cat but it

caused much irritation lower down in the bowels giving rise to dysenteric symptoms.

The active principles obtained from this fruit differed greatly in their physiological action from that obtained by the late Dr. Warden from the fruits of Luffa Echinata (Bindal) which also belongs to this genus, inasmuch as the latter was found to develop profound nervous symptoms, such as spasms, convulsions and paralysis of the limbs, dilatation of the pupils, &c. (see Pharmacographia Indica, Vol. II, page 83). These nervous symptoms were absent in the present case. They, however, agreed so far that they all possessed irritant properties.

One of the active principles, viz., D, from its physical properties, its chemical behaviour and its physiological action appears to resemble closely *Colocynthin*. Both the active principles are glucosides.

My thanks are due to Dr. H. L. Sinha for his help in conducting this investigation, and also to Captain J. A. Black, M.B., I.M.S., for kindly looking over the paper.

In the subjoined table, a list of the more important plants belonging to this Natural Order is given. The sweet varieties are largely used as food ; the bitter varieties are mostly poisonous and are used medicinally only in small doses. It is believed that the edible varieties owe their freedom from poisonous properties to cultivation.

Botanical Name.	Vernacular Name.	Uses.
1. Citrulus Colocynthis.	Beng. Indrayan ..	Active principle, colocynthin, is a glucoside; violent cathartic, ; fatal in large doses.
2. „ Vulgaris ..	„ Turmooj ..	Common water-melon, largely used as an article of food. The seeds of the bitter variety, Citrulus Amarus, are used as purgative.
3. Cucumis Trigonous	Hind. Bislumbi .. W. India. Karit	Fruits of the wild variety used as purgative like colocynth. The ripe fruits of the cultivated variety are eaten.
4. „ Melo ..	Beng. Kankur ..	Seeds used as diuretic. Fruits eaten in unripe and ripe conditions.
5. „ Sativus ..	„ Sasa ..	Seeds used as diuretic. Unripe fruits largely eaten.
6. „ Pepo ..	„ Bilati Kumra.	Cultivated and used as vegetable.
7. Lagenaria Vulgaris	„ Laoo ..	Fruits ordinarily called bottle-gourd; used as vegetable. The bitter variety (Tita laoo) is a powerful emetic and purgative.

BOTANICAL NAME.	VERNACULAR NAME.	USES.
8. Trichosanthus Palmata.	Beng. Makal ..	The fruits possess a bitter principle which resembles to some extent colocynthin.
9. „ Dioica ..	„ Patal ..	Cultivated and largely used as vegetable. The bulbous part of the root is believed to be a hydragogue cathartic.
10. „ Cucumerina	„ Ban-patal ..	This is the wild variety and is used as medicine.
11. „ Anguina ..	„ Chichinga ..	Cultivated for edible fruits.
12. „ Cordata ..	„ Bhooi-Kumra	Used for medicinal purposes.
13. Momordica Charantia.	„ Karola & Uccha	Fruits bitter and wholesome; largely used as vegetables. The wild variety of karola is believed to possess toxic properties.
14. „ Colebinensis	„ Kakrol ..	Used as medicine after delivery.
15. „ Cymbalaria	Mar. Kadavanchi ..	Tuber used in Bombay Presidency as abortifacient. It contains a bitter glucoside.

Botanical Names.	Vernacular Name.	Uses.
16. Luffa Echinata	Beng. Bindal ..	Used medicinally in many parts of India. A bitter active principle like colocynthin was extracted from the fruit by the late Dr. Warden, .01 gramme of this substance proved fatal to an adult cat. Used also as an abortifacient. One fruit proved fatal with symptoms of cholera.
17. " Amara Roxb.	Beng. Ghosalata ..	Fruits emetic and cathartic; supposed to possess diuretic properties also.
18. " Acutangula Roxb.	" Jhinga ..	Both cultivated and wild, the wild variety bitter and poisonous. Fruit of the cultivated variety used as vegetable.
19. Cephalandra Indica.	" Telakucha ..	Root and juice of the leaves used medicinally; the wild fruit is very bitter.
20. Zaneria Umbellata.	" Toruli or Kudari	Fruits and root used in medicine.
21. Corrallocarpuz Epigœa.	Sans. Mahamula ..	Contains a bitter principle which is the same as bryonin; used in dysentery and venereal complaints.

BOTANICAL NAME.	VERNACULAR NAME.	USES.
22. Bryonia Laciniosa.	Sans. Baja Beng. Mala	The whole plant is bitter; it contains a bitter principle similar to Bryonin.
23. Mukia Scarbella.	Sans. Abilekhan (marked like a snake)	The herb is considered to be gently aperient and stomachic.
24. Zanonia Indica.	Sans. Dirghapatra Kuntali or Tiktaka.	Aperient; considered beneficial in asthma.
25. Modeca Palmata.	Not known. ..	Believed to possess severe irritant properties. A fatal case occurred in Madras in 1898.
26. Ecballium Elaterium.	Katri Indrayan of Indian Bazars (not indigenous but imported from Persia)	Powerful cathartic; active principle, Elaterin.

A Brief Survey of Research-work in Chemistry in Bengal.*

I propose to make a very brief survey of research-work in Chemistry in Bengal from its beginning down to the present time, with a passing reference to the work being done in other parts of India.

I think I am right in claiming that the first research work, so far as Bengal is concerned, started in the Calcutta Medical College.

In the forties and early fifties of the last century, we find Dr. O'Shaugnessy teaching Chemistry and Pharmacology to the students of the Calcutta Medical College and holding before them a bright picture of what a systematic study of Natural Sciences was capable of accomplishment in the matter of the development of industries in India. He had great faith in the capability of Indian students, and dwelling upon the difficulties that beset the path of a research-worker, he gave expression to his opinion in the following memorable words in 1842 :—

"Difficulties will beset his progress, it is true, but to overcome them all, he requires only the qualities which the Indian youth possesses in a most pre-eminent degree. He is quick of perception, patient in reflection, adroit and delicate in experimental manipulation, and with these endowments, his full success in this study may be confidently foretold."

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*Read at the Science Convention, Calcutta, 1921.

Modern Review, April, 1921.

We congratulate ourselves that we have lived to see his prophecy to a large extent fulfilled. Dr. O'Shaugnessy's work in connection with the Telegraph in India is of historic interest. He is also remembered as the author of the Bengal Pharmacopœia (published in 1844), which contains much valuable information based upon personal chemical investigation of some important Indian drugs. . .

In the sixties and seventies of the last century, there was little or no enthusiasm for the study of Science in the Calcutta University; for the simple reason that the majority of the students were not in favour of scientific education and the Calcutta Colleges were very ill-equipped for imparting instructions in science to their students. Even the students of the Presidency College used to attend lectures in Chemistry, Physiology and Biology in the Calcutta Medical College. The name of Dr. F. N. Macnamara may be mentioned as one of the most successful teachers of Chemistry of that time. In these days, it was a Bengali doctor, the late Rai Kanny Loll Dey Bahadur C.I.E., who made a special study of Chemistry and taught it first to the students of the Campbell Medical School and afterwards in the Calcutta Medical College where he also carried on the duties of the Chemical Examiner to Government for sometime. He devoted himself mainly to the study of the indigenous medicinal plants and made valuable contribution to our

knowledge of the constitution of some important drugs. His discovery of an important test for Porphyroxyn in Indian opium in 1867 has been very helpful to the identification of the drug in medico-legal cases.

In 1868, Waring issued the Indian Pharmacopœia to which Moodeen Sheriff published a supplement in 1869. In the field of Pharmacology, as observed by Sir George Watt, no names are more distinguished than those of Kanny Loll Dey and Moodeen Sheriff.

They were followed by Wood, Warden, Waddell and Ram Chandra Dutta who in the eighties and nineties of the last century continued their investigation into the chemical composition of the medicinal and poisonous plants of India. Wood was the author of an ingenious and economical process for the extraction of Quinine from the Chinchona bark which was adopted by Government in their Quinine factories. Warden, with the assistance of Hooper of Madras and Dymock of Bombay, published the three interesting volumes of the Pharmacographia Indica which constitute a most valuable work of reference in regard to the history, botanical character, chemical constitution and medicinal virtues of indigenous drugs of vegetable origin found in India.

Much of the original chemical work recorded in this book of reference was done in the laboratory of the Calcutta Medical College and the writer had the privilege of assisting Dr. Warden

in carrying out the investigations to which he could claim a humble share. Babu Ram Chandra Datta distinguished himself by the discovery of kurchicine in the Kurchi bark (Holarrhena Antidysenterica). The writer, in working out the chemistry of Karabi (Nerium Odorum), discovered a new active principle in the plant which he named as Karabin. A brief resûme of the paper was published in the Journal of the Chemical Society, 1901.

Sir David Prain, now Director of the Royal Gardens, Kew, investigated into the chemical and physiological properties of the Ganja (flowering tops of Cannabis Sativa) in the Chemical Laboratory of the Calcutta Medical College. His interesting results were published in a special report issued by the Government of Bengal.

Sir Alexander Pedler made some original investigation himself while he was a Professor in the Presidency College and was for sometime a collaborator of Dr. Warden in his investigation into the chemistry of some of the indigenous drugs. Pedler and Warden succeeded in isolating a neutral constituent from Bengal opium.

Warden and Waddell carried on in 1884 their investigation into the poisonous properties of the Abrus Precatorius seeds (Jequirity or Rati seeds) which are introduced hypodermically in the form of a needle (Sui) for killing cattle in India. Before this, the toxic action of the seeds was believed to be due to the pre-

sence of a bacillus, but Warden and Waddell were the first to disprove it. They discovered a proteid substance in the seeds which they named Abrin (a mixture of globulin and albumose) which was responsible for the poisonous properties and which acted somewhat like snake-poison in the animal system.

It was Sir P. C. Ray, KT., C.I.E., D.SC., the distinguished Indian Chemist and our esteemed colleague, who laid the foundation of higher research-work in Chemistry proper in Bengal while he was the Professor in that subject in the Presidency College. He wrote a paper on "Conjugated Sulphates of the Copper Magnesium group" which was published in the proceedings of the Royal Society, Edinburgh, in 1888. It was followed by his most valuable contributions on the constitution and behaviour of the Nitrites of various metals and organic radicles. Subsequently, Dr. Ray, with the help of his devoted students, organised and started the Indian School of Chemistry in the Presidency College. This School, has, up to the present time, contributed nearly 200 original articles which has been published mostly in the Journal of the Chemical Society and also in other scientific publications in India, England, America and Germany. Dr. Rey himself is responsible for about 50 per cent of these valuable original communications.

Dr. Nilratan Dhar D.SC. (Lond. and Paris) one of the most brilliant students of the Indian

Sir P. C. Ray Kt., C.I.E., D.Sc., Ph.D., F.C.S.

To face page 108.

School of Chemistry, now occupying the Chair of Chemistry in the Muir Central College, Allahabad, has followed in the footsteps of his teacher and has already succeeded in associating with him a good number of pupils in higher re-search work in Chemistry in the United Provinces.

It is satisfactory to note that original contributions by Indians to the Journal of the Chemical Society in 1919 were 18 in number as compared with 10 in 1918, and of these, 94 per cent was contributed by Bengal alone.

Dr. E. R. Waston when he was the Professor of Chemistry in the Dacca College was able to inspire a number of students of his own college with his love and enthusiasm for research-work in Chemistry, and he and his small band of devoted followers have made material contribution to the progress of Organic Chemistry. He is now engaged in organising a Research Institute at Cawnpore.

With the advent of the New Regulations in 1908, the facilities for the study of Science in the Calcutta University have greatly improved. Science courses are being regularly taken up now by a large number of our students. The University Science College and the Post-Graduate Teaching (the latest development of the Calcutta University) have helped still further to advance the study of Science in its higher branches. The Science College, has already made valuable contribution to research-work in Chemistry during the last two years. In 1919,

nine original papers were presented by the Professors of Chemistry and the Research-scholars attached to this institution. We heartily congratulate Dr. J. C. Ghosh of this College on his brilliant achievement as the discoverer of a Law which has since been chirstened after his name.

The research-work in Chemistry has not been of theoretical interest only. Some of the results obtained possess high practical value and have found application in Industrial Chemistry. Dr. R. L. Dutt alone has taken no less than 22 patents for the simple and economical manufacture of various elements and chemical compounds, such as chlorine, bromine, iodine, chromate and bichromate of potash, sulphur, saltpetre, nitro-compounds, caffeine, etc. I heartily congratulate him on the successful practical aplication of his research-work.

The Indian Association for the Cultivation of Science has been silently working towards the same goal and has made its humble contribution to the general progress of research-work in Science. Although it has not been able to achieve such marked success in the Chemical section as in the Physical department, it is hoped that when the Chemistry department is properly re-organised, it will be able to show creditable work in that branch of science.

In the other provinces of India, the progress in chemical research-work is also satisfactory. Much important work is being done in the

Punjab by Bawa Kartar Singh and others. In 1919-20, twelve original papers on Physical Chemistry and allied subjects were contributed to various Indian and foreign scientific journals by this eminent professor and his enthusiastic pupils. In Bangalore, in Pusa, in the School of Forestry at Dehra Dun, in the Government Opium Factories, in various Colleges and Technical Institutions under Government control in this as well as in the other Provinces, valuable work is being done by experts, professors and research-scholars which are likely to prove very helpful to the development of some of the important industries of India.

The Chemical Service Committee have finished their labours and their recommendations are before the Government of India for consideration. Let us hope that best results will come out of their deliberations which will advance the cause of Chemical Research work and contribute to the development of the vast material resources of the country. We hope to see our countrymen occupy a prominent place in the newly-organised Chemical Service of India.

The progress of research-work in Chemistry in all its branches has exercised its influence for good in stimulating various industries in the country. Our young men are visiting England, America and Japan to learn the technique of those industries which are likely to grow successful on Indian soil and are piloting them on their return to India. Thus industries

relating to the manufacture of chemicals and drugs (of which the Bengal Chemical and Pharmaceutical Works Ld. and the Calcutta Chemical Works Ld. deserve honourable mention), pottery, paper, paste-board, soap, leather, glass, etc., have been started in many towns in India, and Indian capital, which was before long very shy of such enterprises, has become less reserved and is coming forward to meet the crying needs of the country. One should not be so sanguine as to expect that all of these new enterprises will stand the test of time and competition, but I have not the least doubt that many of them will survive, wherever there is singleness of aim, honesty of purposes and business experience.

This Science Convention is a hopeful sign of the times. May it grow and prosper and help in advancing the cause of Scientific Research-work in India.

II
MEDICAL.

A Case of Snake-Bite.

Fatik, a Brahmin boy, aged about 11 years, the son of a friend of mine, was bitten by a full-sized cobra at 9[*] p.m., on the 12th September, 1901. The boy was preparing his lessons on the terrace of his house with a kerosene lamp bruning near him. There were other people on the terrace who saw the snake quietly gliding near the boy, and they raised an alarm which frightened the animal, and it bit the boy on the outer-side of the right knee. This snake has several times been seen in the house, but it was not killed or molested owing to a superstitious belief that an injury to a eobra living in a dwelling house would bring ill-luck to the family. The snake escaped into the crevices of an old parapet. It was seen again on the next day and was killed. It measured about five feet in length, and was found to belong to the Gokhura (*Naia Tripudians*) class.

The people had the presence of mind to immediately put two tight ligatures on the thigh above the bitten part. I saw the patient within a quarter of an hour, and took with me a lancet and some permanganate of potassium crystals which I had with me in the house.

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* Indian Medical Gazette, February, 1905.

I found the ligatures quite tight and saw two distinct fang-marks on the outer-side of the right knee-joint about half an inch apart, and there was slight oozing of blood from them. The boy complained of a burning sensation in the part and appeared much frightened, but showed no symptoms of poisoning.

I freely applied the lancet to the bitten part, making crucial incisions which I carried a little beyond the fang-marks all round. A quantity of tarry-looking blood flowed out. I then thoroughly washed the wound with a hot solution of permanganate of potassium and bandaged it tightly up. I sent for antivenin as I thought it would give additional protection in case slight absorption of the venom had taken place, but I could not get it until three hours after the bite (it was not avaliable in any druggist's shop in the town and had to be obtained from the Superintendent of Zoological Gardens Alipur). I injected 10 c.c. hypodermically and repeated it about an hour later. There were, however, no symptoms of poisoning when I injected the antivenin. I have no doubt that the injection was quite superfluous and unnecessary, the poison having been completely destroyed by the local application of the permanganate of potassium.

The wound caused by the knife and the caustic action of the permanganate of potassium took about three weeks to heal; during this

period, the boy had fever for a few days and complained of numbness and stiffness in the bitten limb, which gradually disappeared, and he made a good recovery. The wound was dressed antiseptically.

Some Observations on Diabetes in India.*

These observations are primarily based upon the records of 325 cases of diabetes, 483 samples of whose urine were examined by me during the last six years. It would appear that in many respects, the phenomena presented by the disease in India are different from those observed in Europe and America. Some of them, it is expected, would be interesting to foreign readers, even after making due allowance for the peculiar conditions of living, habits and diet of these patients. So far, the literature in this connection has been very scanty and this is my excuse for placing this paper before this learned assembly.

Etiology.

(1) *Age*—In the majority of my cases, the patients were between 40 and 50 years of age and this is the usual period of the first appearance of the disease in Indians. A comparatively small number of persons contracted the disease under 40, and in a few instances only, the disease appeared before 30. The youngest person in whom I have seen diabetes was a high caste Bengali Hindu aged 18 years. His was a bad case as it usually happens in very young people. Neither dietetic restrictions, nor medicines, nor the influence of a climatic

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* Calcutta Medical Journal, September, 1907.

change did produce any appreciable impression on the excretion of sugar in this case. Dr. U. N. Sen, the late Civil Surgeon of Noakhali (a district in Eastern Bengal), reports to me the case of a male child, aged 6 years, in whose urine he detected a moderate quantity of sugar. The child used to pass large quantities of water and suffered from great thirst which attracted the notice of the parents. The father had diabetes and the grand-father died of the same disease. There was history of syphilis in the family and the child himself suffered from congenital syphilis. Under treatment, the sugar disappeared from the urine in about a month's time. Osler says that the disease is rare in childhood but has recorded cases in children under one year of age. Stern reports six cases in which he detected diabetes in children under one year. Fletcher states that of 506 diabetic patients treated at St. Bartholomew's Hospital during the last 22 years, 27 or 5.4 per cent. of the cases were between 3 and 16 years of age. Dr. B. B. Ghosh of Calcutta detected large quantities of sugar in two Bengali children under two years of age who were suffering from biliarry cirrhosis of the liver. Of course, some of these cases were probably instances of alimentary glycosuria and not of true diabetes.

Here, as in Europe, the diabetes usually runs a short and severe course in the case of young people. I know of a case which proved fatal in four month's time, coma setting in, a

few days before death. The patient was a Bengali aged 28 years. The younger the patient is, the more intractable the disease becomes; and in such cases, excessive thirst, rapid emaciation, burning of the skin and the other classical symptoms of diabetes. which are less marked in diabetes in advanced life, are found to exist. In the young, the diabetes breaks down the constitution within a few years and a young man usually succumbs to the disease within a few years of its first appearance. In elderly people, however, the disease does not for a long time appear to exercise any very marked baneful influence on the constitution. Many of them attain to the usual limit of human life, although passing sugar in moderate quantity for the last 15 or 20 years of their lives.

(2) *Sex*:—The disease is more prevalent among males than in females. The incidence of the disease in the female, among the 325 diabetics whose urine I examined, was only 14 i.e. 4.3 per cent. Of these. 7 were Bengali Hindus, 1 Hindu of another province. 3 Mahomedans, 1 Eurasian and 2 Armenians. The experience of other analysts and medical men whom I have consulted in the matter is in agreement with the above observation. In the table of analysis of urine by Dr. R. C. Dutt, F. C. S., appended to the paper on diabetes by the learned President of this club and published in the Transactions of the first Indian Medical Congress (page 129), there was not a single

lady-patient among the 250 cases recorded therein. Dr. A. Mitra, Chief Medical Officer of Kashmir, published in the same Transactions, notes on 200 cases from the different provinces of India ; his cases also do not include a single female patient. The disease, however, appears to be much more common among the women in Europe and America than in India. The statistics of the John Hopkins Hospital show 61 cases in females out of 156 total treated there, i.e. 39.1 per cent.

But although Indian statistics and Indian experience show that the disease is much less prevalent among females than amongst males, I consider my figures (4.3 per cent) as much too low, which do not represent the actual state of things. There is one fact which must not be overlooked, namely, that the women of India are very reluctant to make their complaints known unless these are of such a nature as to cause much physical suffering : and complaints about the urinary and generative organs particularly, are studiously kept back from the knowledge of their male relatives from a sheer sense of delicacy. This is undoubtedly one of the reasons why so few samples of female urine are received for analysis.

Of the 11 females (Hindus and Mahomedans) out of the 14, nearly all belonged to the highest ranks of the society. Some of them were Maharanis and Ranis, and the rest with one exception belonged to the landed aristocracy.

The exception was a Bengali lady of the upper middle class whose husband was a confirmed diabetic. The two Armenian ladies held high places in Society; the husband of one of them was also a diabetic.

It has been suggested by an Indian practitioner that Hindu widows who, being vegetarians, live chiefly on starchy diet, do not suffer from diabetes. I have, however, detected sugar in the urine of a few Hindu widows.

(3) *Social position and profession*:—Diabetes is pre-eminently a disease of the well-to-do upper classes of the Indian community and herein the Indian and the English statistics agree. According to Von Noorden, both "the statistics for London and Berlin show that the number of cases in the upper ten thousand exceeds that in the lower hundred thousand inhabitants". What gout is to the nobility of England, diabetes is to the aristocracy of India. Both appear to be dependant upon the same cause, viz., *mal-assimilation of food*; and the excess of uric acid in blood in gout and of sugar in diabetes are due to the difference in the kind of food (nitrogenous and carbo-hydrates respectively) used by the two communities. No doubt, cases do occur now and then among the agricultural and labouring classes but their number is very small. It is the indolent aristocracy and the well-to-do middle class men who are most affected by the disease. It is the scourge of the educated section of the

Indian community. Most of our educated men have been disabled and many have been carried away by the disease in the prime of their life. It is very common among the members of the Judicial Service and among wealthy lawyers. 21 per cent of Dr. A. Mitra's cases were either lawyers or law-officers. It is less common among members of the Executive Service, and the cause is not far to seek. The Executive men have to do much out-door work and are, therefore, of more active habits. Their duties keep them in open air for much longer time than their brethren of the Judicial Service. Exercise, as a rule, is disliked by the gentlemen-class of Bengal after a certain age, and members of this Service form no exception. Further, in addition to sedentary habits, excessive mental labour often in over-crowded court rooms, and ingestion of heavy meals chiefly composed of carbohydrates and fat, seem to be no un-important factors in the causation of the disease among this class of highly useful Indian public officers. The sedentary habits of Indian clerks account for 9.5 per cent of Dr. Mitra's cases, while 45 per cent of his cases are individuals who are stated to belong to no profession, which, in India, means owners of landed property, who are noted for their inactive habits.

(4) *Heredity* :—That diabetes sometimes runs in families has come to the observation of all Indian Practitioners. I have seen instances in which the disease has run in the family for three

generations, and Dr. Sen's case mentioned in page 119 is one such. In one family, the grand-father who died at the age of 72, had diabetes of a mild character for the last 15 or 20 years of his life. The father got it at the age of 45; he is now 55 and the disease in his case is also running a mild course. Sugar was first detected in the urine of the grand-son when he was 26 and the amount daily passed by him is pretty large. The disease is now of three years' standing in his case and albumen has already shown itself in the urine. The grand-father was a lawyer and both the father and grand-son also follow the same avocation. Dr. S. B. Ghosh of Calcutta reported to me a case in which the disease also ran for 3 generations in the family. The grand-father was a school-master who suffered from chronic diabetes for several years before death which took place at the age of 62 from severe hæmorrhage from the bowels. The father was a member of the Judicial Service and the disease in his case ran a shorter and more severe course; he died at the age of 55 from carbuncle; his wife also suffered from diabetes. The disease was detected in the grand-daughter at the age of 25. She is the mother of several children. She is now passing about 24 grains of sugar per ounce.

I have seen many instances in which the disease has run for two generations in the family and among several children of a diabetic parent; in many of these cases, it has not yet been time

for the disease to develop in the third generation. In his valuable notes on 200 cases of diabetes already referred to, Dr. Mitra observes that he obtained a distinct history of heredity in 47.5 per cent of his cases. According to Osler, hereditary influences play an important role in diabetes occurring in Europe, and cases are on record of its occurrence in many members of the same family. Naunyn also records 35 out of 201 private cases in which he obtained a family history of diabetes.

Further observations are, however, wanted before diabetes could be pronounced to be a hereditary disease, but the observed cases in which the disease has run for two or three generations, and among several members of the same family, are not inconsiderable and call for a careful enquiry.

(5) *Intemperance*:—Intemperance is not found to be a cause of diabetes in India. In the majority of my cases, the patients were total abstainers, and Dr. Mitra's statistics support my statement. Of the 200 cases recorded by him, 44.5 per cent were total abstainers; 53.5 per cent were of temperate habits, and in only 2 per cent of the cases, he obtained a history of intemperance.

(6) *Race*:—It appears that Hindus are more susceptible to the disease than other races living in India. The statistics of my 325 cases give the following percentage of the incidence

of the disease among the various races :—

Bengali Hindus ..	.. 64.62
Hindus of other provinces	.. 12.30
Mahomedans ..	.. 8.00
Europeans ..	.. 5.54
Jews and Armenians	.. 4.00
Eurasians ..	.. 2.47
Jains	.. 2.15
Native Christians ..	.. 0.62
Parsis ..	.. 0.30

In the statistics of 250 cases in which the urine was examined by the late Dr. R. C. Dutt, F.C.S., the percentage came to 92.4 among Hindus, 0.8 among Mahomedans and 6.8 among Europeans and Eurasians.

In the all-India statistics of 200 cases collected by Dr. A. Mitra, the percentage was 65 among Hindus, 17 among Mahomedans, 4·5 among Europeans, 2.5 among Eurasians and 3.0 among native Christians.

Even taking into consideration the fact of the preponderance of the Hindu population in India over the Mahomedan, the ratio of the incidence of the disease among these two communities, is out of all proportion to their respective numerical strength. For example, the proportion of Hindus to Mahomedans in Bengal alone is roughly 2 to 1; but as shown in my statistics, the disease is found to be prevalent among the former nearly 8 times more than among the latter. Dr. Mitra's statistics show t to be nearly 4 times more. Dr. R. C. Dutt's

figures are, in my opinion, too high for the Hindus and too low for the Mahomedans.

Even making due allowance for the imperfect nature of these statistics, it is quite evident that the Hindus suffer more from diabetes than their Mahomedan brethren. Probably the preponderance of starch and sugar in their diet, their general abstinence from animal food, want of physical exercise and the large amount of brain-work which many of them have to do—some of them being the people most advanced in education in this country—account largely for the inequality in the prevalance of the disease among the two great communities living in India.

English authors have noted the fact that the disease is more frequent among the Hebrews and comparatively rare among the coloured races (Negroes).

Some medical men doubt the existence of diabetes among the Jains who totally abstain from all meat or fish ; but from the table given above, it will be seen that 2.15 per cent of my cases were Jains.

(7) *Worry and mental shock* :—Occupation causing excessive strain on the nervous system, and other matters causing constant worry are known to favour the development of the disease. Death in the family or failure in business causing sudden severe mental shock, is known to have produced the disease in acute form in a good many cases.

(8) *Diet* :—There is no doubt that a diet preponderating in starch and sugar favours the production of diabetes, but this alone is not sufficient to cause the disease. Children taking very large quantities of sugar in various forms are seldom found to suffer from diabetes. Indian agricultural population and Indian labourers consume a diet that is very rich in starch but they are only occasionally found to be suffering from diabetes. In such people, as in children, the constant active movements of the body help the combustion of the excess of sugar and none of it appears in the urine. It is more the quantity than the quality of the food which is responsible for the appearance of sugar in the urine. It is commonly observed that persons who in their youth were large eaters fall victims to this disease in their later life. These persons generally complain of dyspepsia (such as acidity, heart-burn, flatulence etc.), but seldom refrain from taking heavy meals, and it is often noticed that this kind of dyspepsia is followed by diabetes. Too much carbohydrates and fat in diet, want of exercise and excessive mental work are conjointly responsible for the large prevalence of diabetes among the Hindus of India.

(9) *Contagion* :—A few cases have come to my knowledge of the co-existence of the disease in both the husband and the wife. The possibility of diabetes being contagious was first suggested by Schmidt who obtained evidence in 26 cases out of 2320 (i.e. 1.12 p.c.) investi-

gated by him, of the disease being the result of contagion. In all the cases known to me, the disease was first detected in the husband, but it is impossible to say whether it existed in the wife at the same time or even previous to its detection in the husband. The evidence, however, is too meagre to establish the contagious character of diabetes. It is probable that the same causes were in operation and produced the disease both in the husband and the wife.

(10) *Sexual excess*:—Too free sexual indulgence, specially at too early and late periods of life, is believed to be a predisposing cause of diabetes. Elderly men marrying young girls are not infrequently seen to suffer from diabetes. Child marriage has been held responsible by many physicians to be one of the important factors in the causation of the disease among the people ot India.

SYMPTOMS.

As in Europe so in India, two forms of the disease have been recognised, the acute and the chronic. In India, we do not see many cases of the acute type. The acute form is generally found, as has already been stated, among the young people and it usually runs a rapid course. Mild chronic forms are common in people of middle and advanced age; it is the least troublesome form of the disease and generally yields to dietetic treatment. This form of diabetes, although apparently innocent in the

beginning, gradually develops into the severer chronic form of the disease after a few years and then it runs the usual course. This severe chronic form of the disease may be improved under hygienic and dietetic treatment, but is seldom cured.

The symptoms of the disease as commonly met with in India differ somewhat from those recorded in English books, not so much in kind as in intensity. I mention here some of the principal symptoms of the disease noting the points of distinction between the Indian and the European types of the disease.

(1) *Onset of the disease* :—The *onset* is usually insidous; sometimes months may elapse before the patient comes to suspect its presence. The invasion of urinals by ants is in a good many cases the first phenomenon to excite the suspicion of the patient; he consults a medical man for an explanation which leads to the detection of sugar in his urine. In a larger number of cases, the frequency of micturition, specially during the night, and the large quantity of urine passed attract the notice of the patient. In some cases, the appearance of a crop of boils, or the presence of giddiness and general debility leads to the detection of a large quantity of sugar on the analysis of the urine. The frequency of micturition and the increased quantity of urine may be accompanied with dryness of mouth, thirst, wasting and debility, and these cases usually run a rapid course. The onset is sudden

in those cases in which the disease is the result of a mental shock, and all the severe symptoms of the disease are found to occur almost simultaneously in such cases.

(2) *Thirst*:—In the mild chronic form of the disease, thirst is not a prominent symptom; and in this, the flow of urine is usually not excessive. In a good number of cases, however, dryness of mouth and thirst are prominent symptoms and the craving for drink is very marked, patients often drinking enormous quantities of water at short intervals.

(3) *Urine*:—In mild cases, excessive flow of urine is not a marked symptom, the quantity usually keeping between 50 and 70 ounces in 24 hours. In more severe cases, both the frequency of micturition and the quantity of urine are increased and may come to 4 to 6 times the normal. The large flow of urine does not indicate a lesser proportion of sugar owing to dilution. On the contrary, the proportion of sugar usually increases directly with the quantity of urine, and it is the very pale and copious urine which is found to possess a high specific gravity and to contain a high percentage of sugar. The frequency of mictutition causes much annoyance to the patient; but the flow, being excessive, is so easy that I remember to have been told by some patients that inspite of their disturbances, they must admit that it always gave them a pleasurable sensation to pass water.

In cases where diabetes has been brought on suddenly by a severe mental shock, I have seen the flow to be almost continuous for days, dribbling into the urine-pot placed between the thighs of the patient, and so much sugar is passed in such cases that drops of urine, on slight concentration by exposure, feel sticky to the finger like thick syrup. The patient becomes extremely prostrated, scarcely able to sit up and the thirst is very distressing. The prognosis in such cases is usually grave but I have seen people get over the acute attack and live several years in fair health, having the disease in the chronic form.

I have seen frequency of micturition to be a prominent symptom in cases of *Oxaluria* and people suffering from this complaint often suspect that they have got diabetes. It is the examination of the urine which restores peace to the troubled mind. In such cases, the micturition is most frequent in the day-time.

Specific gravity:—The highest specific gravity noticed by me was 1044. In confirmed diabetics, I have detected sugar (though trace) in urine of a specific gravity so low as 1002.

Sugar:—The highest percentage of sugar detected in my cases was 7 per cent. It is frequently noticed that sugar diminishes with the increase of albumen in the urine. When diabetics suffer from fever, sugar usually disappears from the urine. In some cases, it has been noticed that with the appearance of a

carbuncle and specially after the separation of sloughs, the quantity of sugar in the urine is diminished, and this continues for some time after the patient recovers from the carbuncle.

As regards the tests employed for the detection of sugar, I would refer you to any standard book on urine analysis. I may, however, mention here that there are certain substances excreted by the urine which have a reducing action on Fehling's solution. These are, among others, excess of uric acid, urates, creatinin and glycuronic acid. This fallacy may be guarded against by not relying upon one or two tests in doubtful cases. Ordinarily, boiling with liq. Potass and the use of Fehling's Solution are quite sufficient for both qualitative and quantitative purposes. In all doubtful cases when slight reactions are only obtained, the phenyl-hydrazine test producing osazone crystals should also be employed.

Oxalate of lime :—In 26.50 per cent of my cases, oxalate of lime was detected in the sediment. Many people suffering from oxaluria are known to have developed diabetes in their later life, and I have seen cases where sugar and oxalate of lime occurred alternately in the urine. It is possible that in some of these cases at least, they are the two phases of one and the same disease caused by mal-assimilation of food.

Uric Acid :—Uric acid was detected in 14.70 per cent of my cases. Diabetics often make an error on the side of excess in regard to

animal food and this probably explains the presence of uric acid in a good many samples of diabetic urine.

Acetonuria :—Acetone and diacetic acid have been found in the urine of a small number of diabetic patients. I have in some cases failed to detect them in the urine of patients suffering from diabetic coma.* The nature of the toxin causing diabetic coma is not precisely known, but the toxæmia is at present believed to be due to *Beta*-oxy-butyric acid circulating in the blood and other body-fluids; and acetone and aceto-acetic acid are the decomposition-products of the *Beta*-oxy-butyric acid.

Since the completion of this paper, three cases of death from diabetic coma in elderly persons and one of recovery have come to my knowledge. Of the three fatal cases, the patients had been suffering from diabetes for many years and two of them had suffered from carbuncles more than once during the course of the disease. The urine was last examined two days before death in each of the three cases when coma had partially set in. Very marked reactions of acetone and diacetic acid were obtained in the urine of two of the three patients; in the third case, the results were negative. The case of diabetic coma which is on the fair way towards recovery is an old man above 70 years of age. He is a lawyer by profession and has

* These were probably cases of *uraemia* and not of *true diabetic coma*.—EDITOR.

been suffering from the disease for a long time. The coma was just developing but it had been arrested under treatment. Marked reactions of acetone and diacetic acid were obtained in his urine.

According to Fletcher, acetonuria is almost invariably met with in diabetes in children and is of much graver significance in children than in adults. Out of 27 cases of diabetic children, Fletcher states that acetonuria was detected in the urine of 26.

(4) *Appetite*:—Though voracious appetite is considered to be a very frequent symptom of the European type of the disease, it is found to be less common in Indian diabetics. In many people, the appetite does not appear to be very keen. People who were large-eaters in their younger days usually retain this habit while suffering from the disease.

(5) *Constipation*:—Constipation of an obstinate type is generally found in diabetic patients.

(6) *Wasting*:—This is not marked in most cases in the Indian type of the disease. Diabetic patients in India are often found fat and stout; in fact, when a person grows fat, he and his friends suspect that he is going to get diabetes soon. In acute cases, however, rapid loss of weight and emaciation are prominent symptoms. The lower limbs frequently show weakness due to the wasting of the calf-muscles which is well-marked in many cases.

(7) *Skin* :—Dryness of the skin, so frequently described in English books, is generally absent in the Indian type of the disease. Here we find the skin acts fairly in most cases, and in some instances, there is copious perspiration even in the cold months.

Inspite of the free activity of the skin, the patients generally complain of a sensation of severe burning of the skin. The skin becomes irritable and liable to frequent out-breaks of boils, carbuncles and other forms of skin disease. The chief characters of skin diseases occurring in diabetes are their itchiness, their obstinacy to heal up and their tendency to recur. Eczema is the commonest form of skin disease found in diabetic patients; it is generally obstinate and troublesome. Cracks and chronic inflammatory processes are generally found on the prepuce due to constant irritation by the saccharine urine. Troublesome eczematous sores are also found on the vulva from the same cause. Pruritis also frequently troubles diabetic patients. The skin affections are the results of general defective nutrition in diabetes which is more or less shared by all parts of the body.

(8) *Impotence* :—Diabetics in India often have large families. Impotency is not found to be a prominent symptom in the Indian type of the disease as has been stated by some writers. People suffering from diabetes for many years are known to have become fathers of many children. Some instances are known where

posthumous children have been born of fathers who were confirmed diabetics. Sterility in diabetic women is not a commonly-observed fact in India.

(9) *Nervous symptoms* :—*Vertigo* is a common complaint of diabetic patients and it has often led to the discovery of the disease.

Neuralgia and *neuritis* are sources of great trouble to some diabetic patients; they are usually confined to the lower extremities but the upper-limbs and other parts of the body may be affected. Sclerotic changes similar to those occurring in Tabes have been detected in the posterior columns of the cord in death from diabetes and to these are attributed the lightening pains, the girdle sensation, ataxy &c., met with in certain cases of diabetes.

The intolerable burning sensation of the skin so frequently complained of by diabetic patients has been described by some to be a form of neuritis.

(10) *Coma* :—The fatal termination in many cases of diabetes is preceded by coma. Its onset is generally gradual; for a few days, slight wanderings of thought may be observed accompanied with a tendency to drowsiness; this is followed by stupor which deepens into coma ending in death. During the comatose condition, an apple-like aromatic odour has been noticed in the breath of the patient.

Complications.

(1) *Albuminuria* :—This is the most frequent complication of diabetes. When a person continues to pass sugar in moderate quantity for some time, traces of albumen invariably appear in the urine and a few pus cells could be detected under the microscope. This is due to the irritation of the urinary passages caused by saccharine urine. In most cases, the kidneys become more and more affected with the progress of the disease; the albumen increases in amount, pus cells become more numerous, and tube-casts are detected in the sediment. In 47.41 per cent of my cases, a trace of albumen was detected in the urine, and in 17.39 per cent. albumen was present in measurable quantity varying from $\frac{3}{4}$ to $\frac{1}{100}$ by volume. The tube-casts are usually not many in number and may be either granular or hyaline or more commonly both. Sometimes an acute attack of nephritis supervenes over the chronic affection and then blood, epithelial casts and renal epithelial cells are seen along with the granular and hyaline tube-casts. This generally happens when the patient is troubled with a carbuncle or cellulitis or gangrene of the extremeties, and the prognosis in such cases is always very grave. The quantity of albumen has generally been found to vary inversely as that of sugar. When albumen continues to be excreted in large amount with numerous casts but with traces or even

absence of sugar in the urine, we know for certain that the poor patient has not many days to live. All the symptoms of chronic albuminuria begin to appear; puffiness of the face, œdema of the whole body and of the lungs, dilatation of the heart, all come in rapid succession; the patient complains of breathlessness and suffers badly from dsyspnœa, and coma generally ends the scene.

Albuminuria is not often singly responsible for the fatal termination. It is frequently found associated with one or more of the following complications.

(2) *Pulmonary phthisis* :—It is a much less frequent complication than albuminuria but often found associated with it. The onset is insidious and chest-symptoms may be altogether absent in the beginning. It seldom begins with hæmoptysis, though in the advanced state of the disease where large cavities are formed, much blood may be expectorated and death has taken place suddenly from rupture of pulmonary blood-vessels.

Phthisis in diabetes has been noticed to affect the bases of the lungs in many cases. This disease occurs in patients of different ages. The course of this complication is very rapid. Tubercle-bacilli abound in the sputum.

(3) *Carbuncle* :—This is a complication which carries away a large number of diabetic patients in India. Some patients appear to be

peculiarly susceptible to this complication, carbuncles or crops of carbuncular boils appearing almost annually with the advent of the hot season. Many, however, tide over the first few attacks, but their vitality gradually gets undermined and they ultimately succumb to a more severe attack. Carbuncles may appear on any part of the body, but those on the back and on the nape of the neck usually assume a severe character and terminate fatally.

(4) *Cellulitis* :—Slight injuries are often found to be followed by cellulitis in cases of diabetes. Diabetics have good reasons to dread even the prick of a pin.

(5) *Gangrene* :—This is a less frequent complication than carbuncle but usually terminates fatally. It generally attacks the extremeties and may occur spontaneously but in most cases may be traced to some traumatic origin, often of a very trivial nature, such as a scratch, the prick of a pin or of a shoe-nail. It often starts from the great toe and there may or may not be premonitary symptoms such as pain and tingling, either of a continuous or intermittent character. So long as it remains confined to the toe or the dorsum of the foot, it usually presents characters of the dry variety ; the parts shrivel up and assume a dark color. When it spreads beyond the ankle, the disease generally assumes the moist type. Its progress, though slow, is seldom arrested and death ultimately occurs by blood-poisoning.

Gangrene occurs more frequently in males than in females. Many cases of so called senile gangrene have been found to be cases of diabetic gangrene.

The cause of diabetic gangrene is primarily sclerotic change in the arteries. It is seldom seen in young people, but invariably occurs in people of advanced age. Wallace in his paper on "Diabetic Gangrene" published in the July Number of the Practitioner states that of 26 cases of diabetic gangrene treated in St. Thomas's Hospital, extensive sclerosis of the arteries were detected in 24. In addition to the condition of the arteries, the general unhealthy condition of the tissues due to defective nutrition prevents the inflammation set up in the gangrenous process from assuming a healthy character.

(6) *Special organs* :—

EYE—*Cataract* is the chief occular complication in diabetes and it is the only form of cataract which is amenable to improvement by general treatment. Cases are on record where a cure was effected even after the formation of striæ by reduction of sugar in the urine. Occurrence of cataract in a comparatively early age is generally due to diabetes; usually both eyes are affected simultaneously. Operation is not very encouraging and is attended with some risk as it is known to have been followed by coma in some cases. In case of cure, the healing process is generally unduly protracted.

Retinitis and hæmorrhage in the retina and other parts of the eye are rare complications.

EAR—Deafness has been known to be a complication in some cases of diabetes.

PATHOLOGY.

I have purposely avoided touching upon the pathology of the disease. The subject is outside the scope of my paper which mainly deals with a few observations of a clinical nature. It must, however, be admitted that our knowledge of the pathology of this disease is still defective. At the present moment, the liver, the pancreas, and the central nervous system are individually or collectively held responsible for the incidence of the disease. The opportunities for making post-mortem examination in India in cases of death from diabetes have been very few; diabetic patients seldom remain long in hospital for treatment and permission for postmortem examination is as a rule refused by the relatives in case of death in hospital. Indian observations on the morbid anatomy of the disease are, therefore, totally wanting. The reader is referred to the European and American literature on the subject.

TREATMENT.

So long as our knowledge of the true cause of the disease remains imperfect, its treatment will necessarily have to be confined to the alleviation of the symptoms only.

In the treatment of a case of diabetes, our first and foremost effort is to try to lessen the

quantity of sugar in the urine which is mainly responsible for many of the troublesome symptoms, such as polyuria, excessive thirst &c. We try to reduce glycosuria, (1) by administration of drugs, (2) by restriction of diet, and (3) by attention to hygiene. I, therefore, propose to consider the subject of treatment under three separate heads:—(1) medicinal; (2) dietetic, and (3) hygienic. The scope of my paper will not permit me to make more than a very brief reference to each method of treatment.

(1) *Medicinal*—A large number of drugs has from time to time been reported to have a specific action on diabetes; although clinical experience, both European and Indian, conclusively shows that none of these has any claim to be considered as a specific, yet some of them have proved to be of considerable value in the treatment of the disease.*

Of these so called specifics, opium and its two chief alkaloids, codeine and morphine, still hold a pre-eminent position over all other drugs in the treatment of this disease. Opium is much more freely used in India than in Europe in the treatment of diabetes, for the simple reason that the dread in which the "opium habit" is held by the European physician is not shared by his Indian brother. Opium-eating is very prevalent in India, specially after the age of 40;

* The recent discovery of INSULIN, although still on its trial, promises to be a very potent agent in the treatment of diabetes mellitus, specially in its serious complications.—EDITOR.

and although "opium habit" is as much obstinate of cure in Europe as in India, its effects are not at all so dreadful as have been depicted by European authors; and we frequently find opium-eaters of long-standing (unless the daily dose is excessivley large), retaining their usual vigour of mind and body consistent with age, climate and other environments up to the last day of their life. According to our Indian experience, opium or its alkaloid codeine is the only reliable drug in the treatment of this disease. It reduces the quantity of urine, lessens glycosuria, relieves thrist and burning sensation of the skin, and generally gives a sense of comfort and tone to the system. Opium has, however, the disadvantage of aggravating the already obstinate constipation of diabetes, and codeine is preferred to opium for its less constipating effects. With some people, however, opium agrees better than codeine which is undoubtedly equally effective in the reduction of glycosuria. Codeine is usually combined with nux vomica and some vegetable laxatives to counteract its constipating effects. Under opium-treatment, Apenta water may be regularly taken in the morning to keep the bowels open.

Many European physicians have recognised the value of opium in the treatment of diabetes. It has been found to give very satisfactory results in the hands of Pavy, Kaufman, Von Noorden and other eminent European physicians. It is not yet known to what the beneficial effects of

opium are due; some ascribe them to impairment of appetite and consequent reduced ingestion of food; others, to its sedative action on the nervous system. There is much to say in favour of the latter theory.

Where much albumen is present in the urine or when coma is threatening, opium is absolutely contra-indicated. It should be temporarily stopped when acetone and diacetic acid are found in the urine, although in many cases, these are not followed by the development of coma.

Opium is generally well-borne by diabetic patients.

Salicylate of soda and aspirin:—Dr. Williamson of the Royal Infirmary speaks favourably of salicylate of soda and aspirin in the treatment of diabetes (Practitioner, July 1907), and says that these have given better results in his hands than opium and its alkaloids. He commences with 10 grain doses of salicylate of soda three or four times a day increasing it to 15 grains or more if necessary. The effects of the salicylate should be carefully watched as it may sometimes give rise to toxic symptoms. He prefers the natural salicylate to the artificial preparation.

Dr. Williamson found aspirin less liable to produce toxic symptoms than salicylate of soda. His dose is 10 grains 3 times a day which may be increased to 15 grains. He has published details of a few cases which were undoubtedly

benefited by the use of these two drugs and says—"the records in my cases show clearly that salicylate of sodium and aspirin both have a definite action in certain cases and cause a diminution of sugar-excretion without producing injourious effects. The good effects of the treatment with salicylate of soda and aspirin are observed chiefly in the milder form of diabetes, and occasionally in severe forms in young people, they diminish and check the sugar-excretion temporarily. When cases are complicated wuth cardiac failure, or nephritis, it is best to withhold those drugs."

Salicylates and aspirin have been found to be of great value in the treatment of diabetes associated with gout. Aspirin has also the advantage of relieving neuralgia associated with diabetes. To it is also ascribed by some "an increased tolerance for carbohydrates, as during its administration, the patient's weight has been seen to increase, so that the diminution of glycosuria can not be in such a case the result of impaired digestion of food."

Uranium nitrate has been found by West and Duncan to reduce glycosuria in some cases. Duncan is of opinion that the drug in order to to be effective should be used in large doses (12 to 15 grains three times a day after food).

Jambul seeds and their preparations have been tried with indifferent results. Some practitioners believe that this drug has marked sugar-reducing properties, but others consider

it as useless.

Santonin has been tried with good results in diabetes. Sajournet says that under its influence, the sugar was reduced, polyuria decreased, the patient's strength improved, thirst diminished and the mouth became less dry. It is given in the average dose two or three times a day and kept for 14 days, the patients being also given alkaline medicines such as carbonate or benzoate of lithia. The santonin is stopped after a fortnight and then resumed again after 20 or 25 days. It is said that two or three such courses of santonin are generally required; the alkaline medicines, however, must be kept up during the interval.

Alkalies :—These have no direct action on the excretion of sugar, but they improve the digestion and the general condition of the patient. In cases where the approach of diabetic coma is apprehended and the urine gives marked reactions of acetone and diacetic acid, bicarbonate of soda in large doses, aided by free purgation, has been known to postpone the crisis. One to two ounces of bycarbonate of soda or more may be given in 24 hours. A few cases in which coma has already set in are recorded to have recovered under the alkaline treatment, soda bicarb having been freely administrated intravenously as well as by the mouth.*

* Along with bicarbonate of soda, potassium citrate in drachm doses three times a day has been found to be very effective, on account of its being formed into carbonate in the system. Rectal injection of soda bicarb with glucose may also be given with advantage.—EDITOR.

The treatment at the different watering stations in Europe by the use of mineral waters is known to have benefitted many patients, specially those suffering from obesity. The good results appear to be due to the healthy and favourable environments leading to improvement of the general condition of the patient and not to any specific action of the waters.

Bromide of potassium, antipyrin, quinine, arsenic, phosphate of lime, iron and a good many other drugs have from time to time been used with doubtful results. Some of them improve the general condition of the patient and thus indirectly exert beneficial influence on the disease.

Ferments such as diastase, and *extracts of liver and pancreas* have been tried with conflicting results.

New remedies:—Among the new remedies may be mentioned *diabetserin*,, *antimellin*, *saccharosolvol*, *glycosolvol* and *senval*. (*Pract. July*).

The principal ingredients of diabetserin are chloride, sulphate and carbonate of sodium, sulphate of magnesium, glycero-phosphate of lime and eserine. It is believed to counteract the arterio-sclerotic changes to which some people attribute the causation of the disease. Frankel of Berlin obtained good results from its use in 22 out of 29 cases.

Antimellin contains opium, salicylic acid and jambul, and has been used with benefit in many cases.

Saccharosolvol is a preparation of salicylic acid, and *glycosolvol* contains jambul seeds and much starch.

Senval contains salts of sodium, magnesium and lithium with valerian, peppermint and a few of the aromatic compounds.

As usual, the use of these drugs has been attended with benefit in some cases but not in others.

(2) *Dietetic treatment* :—It may be stated in the begining that in almost all cases of diabetes, restriction of diet is followed by reduction of sugar in the urine, and in a good many cases, the sugar altogether disappears under strict regimen. But although the remedy appears to be so simple, it is somewhat difficult of practical application, especially in the case of Indian patients. The dietary of an Indian consists chiefly of starch and sugar and when these are largely cut off and replaced by meat or fish, the patient not only resents but his appetite and general health are found to suffer also. I have known even Europeans whose principal diet is meat showing intolerance of strict regimen for any great length of time. Fortunately, however, we need not carry out the dietetic restrictions to extreme. It is not necessary that the whole of the carbo-hydrates should be cut off from a patient's diet; in fact, such a step is attended with some risk, as I shall explain later on. Every diabetic patient has some tolerance for carbo-hydrates and this varies

with different individuals. In all mild cases, when the patient lives within this limit of tolerance, he assimilates all the carbo-hydrates and ceases to pass sugar with his urine. We must, therefore, find out this limit of tolerance for carbo-hydrates in each case. The task at first sight may appear to be complicated and difficult of being carried out in private practice, but a little consideration of the details will show that it is easy of application even in the midst of a busy practice. Labbe in his paper on "Diet in Diabetes" published in the July number of the "Practitioner" lays down the following simple rule for estimating the tolerance for carbo-hydrates in diabetic patients :— The first day on which the patient comes for advice, observation should begin without as yet changing anything in his diet, by directing him to weigh separately each article of food he eats and to collect the whole of the urine passed, during the space of 24 hours. From the food is then calculated the amount of carbohydrates ingested, and from the urine the quantity of sugar excreted ; the comparison of these two results shows whether the patient has a tolerance for carbo-hydrates and what is the approximate value of that tolerance. The difference between the total amounts of carbohydrates ingested and that of the sugar excreted gives the apparent tolerance."

"When this apparent tolerance has been ascertained, the patient must be put on a diet

containing a reduced amount of carbo-hydrates, lower than his tolerance. It is very much better not to reduce the diet too abruptly, but to proceed gradually, for in this way, the glycosuria disappears more slowly but more surely".

"When the stage of sugar-free urine* has been reached by the foregoing treatment, it is necessary to prevent the re-appearance of hyperglycæmia (excess of sugar in the blood) by instituting a carbo-hydrate diet, which is lower than or at most equal to, the patient's tolerance. The actual tolerance is determined in the following way: as soon as the urine becomes sugar-free, the amount of carbo-hydrates is gradually increased until sugar again appears whereupon the amount is once more reduced until the glycosuria disappears. The actual degree of tolerance for carbo-hydrates lies between the last two amounts tried, that which causes, and that which does not cause, sugar to appear in the urine. As the tolerance remains stationary, for almost an indefinite period, barring complications, it is enough to keep the patient upon a diet slightly lower than his tolerance in order to prevent the reproduction of symptoms of hyperglycæmia".

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*According to recent experiments, the aim in treating diabetic patients should be directed in trying to keep the *blood-sugar level* within normal limits, and the fact of *urine being sugar-free* is not of much importance.—EDITOR.

Now, it is not at all difficult to carry out the above directions in private practice. The percentage of carbo-hydrates in rice, wheat, potato, milk, sugar and other ordinary articles of diet are known; and if the weight of each article of food taken by the patient is known, we can at once calculate the amount of total carbo-hydrates consumed by him in 24 hours. Then if we keep the urine of 24 hours and estimate the quantity of sugar in it, the latter represents the quantity of carbohydrates which the patient has no power to assimilate in his system. Neither the weighment of the different articles of diet, nor the daily estimation of sugar in the 24 hours' urine is a matter of insuperable difficulty in private practice. The first may be left to the patient himself and the last may be done by the medical attendant or his assistant in his own clinic.

It is to be noted that some carbo-hydrates are better tolerated by diabetic patients than others, and that all starches are not of equal value in the treatment of diabetes. For instance, European physicians have found that potatoes and oatmeal are much better tolerated than wheat or rice, and our experience is that wheat is less harmful than rice in this part of India at least. "From a large number of comparative observations, Labbe fixes a scale of tolerance for the usual starchy foods arranged in the following order:—

Potato, oatmeal, macaroni, chestnuts,

rice, harricot beans, lentils (*Dal*), peas, milk, bread, and sugar.

He classifies the carbohydrates allowable to diabetic patients under two heads—the fundamental and the accessary. The fundamental carbohydrate food is absolutely necessary for the patient; the accessory carbohydrates (which generally contain a very small proportion of carbohydrates) consist mostly of green vegetables, such as cabbage, cauliflower, cucumber, salads etc. The fundamental carbohydrate, according to Labbe, is potato and this takes the place of bread which he prohibits on account of the inferior utilization of its starch by diabetic patients. Labbe puts no faith in the so-called special diabetic breads like gluten-bread etc., not only for their uncertain composition (some of them contain a large percentage of starch) but for their unpleasant flavour and more or less indigestible character. Potato contains on an average 20 p. c. of starch and to a patient with tolerance of 100 grms. of carbohydrate, Labbe would allow 90 grms. of potato starch which would be obtained from 450 grms. of raw potatoes per day (a little less than a pound). To break the monotony of the diet, the potato may be replaced wholly or partially by another kind of carbohydrate such as bread, rice etc., but the latter must be allowed in such quantity that the limit of tolerance for carbohydrates is not exceeded. Labbe gives the following

table showing the quantity of different foods able to provide 100 grms. of carbohydrates :—

Potatoes ..	.. 500 grms.
Bread ..	.. 190 ,,
Dry Peas ..	.. 170 ,,
Rice ..	.. 112 ,,

It will be seen from this table that if we wish to "replace 450 grms. of potatoes by an isoglucosic amount of rice which contains 79 p. c. of starch, we must order 112 grams of rice a day", i. e. about 4 ounces of rice. But as has already been stated that diabetic patients can assimilate a larger quantity of potato starch than rice, we ought to allow a smaller quantity of rice starch than what would be proportionately equivalent to the quantity of potato starch tolerated. According to Labbe, the prohibited foods are ordinary bread and diabetic breads, cakes of all sorts, biscuits, pastries, dried vegetables, food paste, rice, chestnuts, the various farinas, chocolate, sugar, sweetmeats, jams, fruits, milk, sweet wines, cider, beer and syrups. But some of them can safely be allowed to patients when their quantity does not exceed the limit of tolerance.

According to our Indian experience, a mixed diet suits best in most cases of diabetes. In the morning, wholemeal *chappaties or puris* or bread may be given, but as a Bengali can not do without rice for a long time, this may be allowed at intervals in small quantity with his morning meal. Potatoes should be more

liberally allowed and fish and green vegetables, some vegetable oil, butter or ghee and a moderate quantity of milk should complete the morning meal of a Bengali patient. For lunch, fruits which are not too sweet, some oatmeal porridge or a few plasmon biscuits, one or two half-boiled eggs and a cup of tea without sugar may be taken. *Saxin or saccharin* may replace sugar in tea or porridge but too much of these substances should not be used, as they have been found to irritate the kidneys and increase the amount of albumen in the urine.

The evening meal should consist of wholemeal *chappatties or puris* or bread if liked by the patient, some preparation of meat, potatoes, butter or ghee, green vegetables and some sour milk.

For vegetarians, *dal* and casein (*chhana*) should be substituted for meat, fish and eggs in the dietary. It should, however, be remembered that *dal* contains, besides the *proteid* (legumin), a large proportion of starch, so that its quantity must be so regulated that the total amount of carbohydrates taken by the patient in 24 hours must not exceed his limit of tolerance. A good quantity of milk should always be allowed to vegetarians.

In severe cases, a much stricter regimen is required and it may be necessary to withhold all carbohydrates for the time being. In some of these cases, even the total elimination of carbohydrates from the dietary does not make much

impression on the excretion of sugar; and in these cases, the sugar is probably formed from foods other than carbohydrates, namely, proteids and fats. There is, however, some danger in suddenly cutting off carbohyderates from the diet of a diabetic patient and replacing them by flesh-food. According to Dr. Brown, such a step is usually "followed by nausea, vomiting and loss of weight and the odour of acetone in the breath, the presence of these acids in the urine and a great increase of ammonia in the urine", It is also known to have brought on diabetic coma. These symptoms disappear as soon as carbohydrates are re-introduced into the diet of the patient.

Diabetics generally tolerate fats well and these should replace the carbohydrates in the dietary as much as possible in order that the loss of heat entailed by the withdrawal of the latter may be compensated. But too much fat should be avoided, not only because it causes obesity but that an excess of fat in the diet has been known to cause acetonuria. In cases where acetone and diacetic acid are persistently present in the urine, or where coma has actually set in, nitrogeneous and fatty foods should be cut down as much as possible and carbohydrates should be freely given at the risk of increasing the glycosuyria which is the lesser of the two evils.

Milk in some form or other is a very important article of diet with the Indians and it

is almost a necessity with those who altogether abstain from flesh-food. It has-been extolled by some as a cure for diabetes, while others have classed it among the prohibited foods. The classical treatment of diabetes by skimmed milk only, finds little favour with the medical men of the present day. It is considered not only unnecessary but positively cruel to put as a matter of routine all diabetic patients exclusively on skimmed milk. According to our Indian experience, milk agrees well with most diabetic patients when not given in too large a quantity. Where an exclusive milk diet is prescribed, 2½ to 3 seers of milk may be allowed in 24 hours. Milk helps to keep down the thirst, relieves constipation and diminishes the glycosuria; and herein our Indian experience is at variance with that of most European physicians. When the disease is complicated with much albuminuria, an exclusive milk diet has generally been found to be of utmost value to the patient. I have seen some bad cases of diabetes improve considerably under an exclusive milk-diet. The difficulty is that some people can not tolerate milk in large quantity and others resent it for its monotony when continued for any length of time. It is, however, not necessary, except in some special cases, to prescribe an exclusive milk-diet. But milk should be allowed in moderate quantity to all Indian diabetics if it does not disagree with them.

Sour milk or *dahi* and butter milk or *ghol* agree with most people --even with those who can not tolerate milk. As most of the milk-sugar is changed into lactic acid in the sour milk, it ought to form a valuable article of diet for a diabetic patient. In regard to the statement that lactic acid increases glysosuria, it requires further confirmation.

There is some difference of opinion as regards the use of fruits in diabetes. Both European and Indian physicians generally agree in withholding sweet fruits from the dietary of a diabetic patient. But some physicians have seen much good to follow the free use of fruits in diabetes. Dr. E. S. K. Aiyer of Mysore observed at the meeting of the Indian Medical Congress in 1894 that sugar entirely disapppeared from the urine of one of his patients who lived exclusively on fruits The urine continued free from sugar so long as the patient remained on fruit but the moment he took his ordinary diet of rice and vegetable, sugar re-appeared in his urine.

Of all kinds of sugar, levulose (fruit sugar) has been found to be the least and the dextrose (grape sugar) the most harmful in glysosuria, and milk sugar and cane-sugar occupy a middle position. Fruits usually contain both levulose and dextrose of which the former occurs in larger porportion. Mangoes, lichis, oranges, apples etc., may be allowed in small quantities only but grapes which contain dextrose should

be withheld. Plantains, custard apples, guavas, dates, raisins, sweet oranges, papaya, jack-fruits etc., which are too sweet, should better be not allowed. Sub-acid fruits, such as pine-apples (not the Singapore variety), pomegranates, pumellos and ordinary oranges, pears, peaches, black jambul (*kalo-jam*), etc., may be given more freely, as they relieve the thirst and increase the alkalinity of the blood; they also act as mild laxatives.

Oatmeal cure :—I have already said that diabetics do not equally tolerate all kinds of starch. Von Noorden found encouraging results in some severe cases of diabetes by the use of oatmeal at the exclusion of other carbohydrates; and even in some cases of advanced coma, the use of oatmeal was followed by good results. European physicians have found that oatmeal, next to potato, is better assimilated by diabetics than other carbohydrates and there is no reason why oatmeal should not find an important place in the dietary of an Indian patient.*

(3) *Hygienic treatment* :—A moderate amount of exercise is as important a factor in the treatment of diabetes as strict regimen. It reduces glycosuria, improves the power of assimilation of carbohydrates, and throws less burden on

* Allen's diatetic treatment with some modifications is also practised with advantage in India. Graham's line of treatment is preferred by some in England. For details, please refer to the paper—*A General Review on Diabetes*—published in the Indian Journal of Medicine, December, 1923.—EDITOR.

the kidneys by causing the skin to act more freely. I have often found slight glycosuria disappear on the patient taking to walking regularly for a few miles a day without making any alteration whatever in his usual diet. As the people of Bengal are very averse to take to any form of exercise, it should be the duty of every physician to exact from his patient implicit obedience to his instructions in the matter of physical exercise. 5 to 6 miles' walk in the early morning is generally sufficient for ordinary patients; this may be coupled with practice on dumb-bells for 15 to 30 minutes in the case of younger persons. In the evening, tennis may be played for one or two hours, or the patients should walk not less than 4 miles. In the case of the residents of Calcutta, they should avoid walking in the dusty and crowded streets of the town but should proceed to the *maidan* by carriage or tram and there perform the walking exercise in the open air.

Diabetics should try to remain in open air as much as possible. Close and over-crowded rooms should be avoided. If their occupation compels them to remain long in a crowded room, they should come out for a short time at regular intervals to breathe pure air out-side. The bad practice with many people in Bengal to sleep in closed rooms for fear of catching cold cannot be too strongly condemned, and I can not too strongly insist upon this point as I

believe that not a few cases of glycosuria here are the direct result of confinement for many a long hour during the night in closed, and often over-crowded, bed-rooms.

Sugar is found in the urine of patients suffering from carbonic acid poisoning, and who can say that the continued breathing for hours of re-breathed-air (surcharged with carbonic acid gas) in the closed and over-crowded bed-rooms is not responsible for the wide prevalence of the disease in this country. Our agricultural and labouring classes either sleep in open air for the greater portion of the year, or in thatched huts which, from their very construction, secure sufficient ventilation of the rooms and this may be one of the causes of their comparative immunity from the attack of this disease. Even in the cold weather, the bed-rooms should be kept sufficiently open to ensure thorough ventilation, care being taken to avoid draught.

The skin should be kept scrupulously clean but should never be rubbed too hard with the towel. Daily baths are necessary for most diabetic patients, as it keeps down the burning sensation of the skin and increases its activity. Bathing in too cold water should be avoided, and when the kidneys are in trouble, water at the body-temperature should be used. A little Scrubb's liquid ammonia may be advantageously added to the bath. Under-clothings should

be of warm material in all seasons if the patient can bear them; they should be frequently changed and washed. The use of dirty napkins is known to have produced crops of carbuncular boils and dirty clothings aggravate them.

Too much work, either mental or physical, should be avoided. Light reading, pleasant company and music are best calculated to relieve the mind of worry and anxiety and should be availed of as often as possible.

Invitations to dinner should be avoided. The keeping of a single invitation is known to have undone the good work of a strict diet maintained for many months. Nothing is more harmful to a diabetic patient than excess of food or irregularities in diet.

Change of air to a bracing climate, preferably the hills, should always be availed of, if practicable, at least for a month during the year. Diabetics going to the hills are often seen to make rapid improvement in health; the glycosuria is diminished and the body-weight is increased.

Chills should be guarded against, specially when the disease is complicated with albuminuria.

Surgical operations:—In these pages, I have tried to give a brief account of the general treatment of diabetes and I have no intention to discuss here the treatment of special complications, such as carbuncle, gangrene, albuminuria, phthisis etc., In regard to surgical

operations, it may be generally stated that diabetics as a rule bear operations badly and the healing process in their case is found to be very slow. But operations have to be undertaken in many cases, and in not a few, it offers the only chance of life to the patient. Presence of much albumen with casts in the urine is an extremely unfavourable complication for surgical operation. Carbuncles when opened early and freely, generally show favourable results and sugar has been known to disappear from the urine after the performance of the operation. Septic conditions prevailing in carbuncle and gangrene increase glycosuria, as the power of patients to assimilate carbohydrates under septic condition is lessened. The case recorded by Wallace in his paper on "Diabetic Gangrene" ("Practitioner", July, 1907) supports this view. Wallace also cites two cases of carbuncle in which the separation of sloughs was followed by cessation of glycosuria.

In gangrene of the extremities, amputation of the limb is generally unsuccessful; but as it has been performed with success in a few cases, and as it is sometimes the last and the only chance for the patient, it should be tried under favourable conditions.

I have given you a brief out-line of some of the important features of a disease which has justly been described as the scourge of the educated Indian community. I am sure

the observations of the learned members of the Profession, present in this hall to-night, that will follow the reading of my paper will put right many defects and shortcomings found in it and will throw light on many a doubtful point raised in the paper. In conclusion, I have to thank you sincerely for the patient hearing you have given me.

I should not sit down without acknowledging my obligation to Dr. Sasi Bhusan Ghosh M. B., Dr. Nil Ratan Sircar M. A., M. D., and Dr. Satyendra Nath Sen M. B., for the help I have received from them in the preparation of this paper.

Prevention of Small Pox.

Small-pox is one of the most dreadful and dangerous diseases to which human body is subject. There are many reasons why it is so much dreaded. First of all, it is a disease which is readily communicable from one person to another; it affects those who come in contact with the patient as well as those who are far away from the sufferer, its infection being carried to distant places through human agency, by air and by infected clothes, beddings and furniture. In the second place, it is one of the most fatal diseases known which carries off hundreds and thousands of people in a single epidemic (unless protected by some special means to which I shall refer later on). Instances are not unknown in which vast tracts of prosperous and thickly-populated country have been desolated and whole tribes of men swept out of existence by periodical outbreaks of small-pox epidemic. Then again, the painful nature of the symptoms and the shocking appearance of the patient in the severer forms of the disease naturally make people view it with horror and repugnance.* And lastly, the

* Calcutta Medical Journal, March, 1915.

permanent disfigurement it leaves behind in case of recovery and the irreparable injury it does to some of the vital organs, such as the organs of sight and hearing, make it all the more loathsome and fearful.

But although it is such a dreadful disease, it is one which is absolutely preventable, at least in its epidemic form. During recent years, its ravages have been considerably mitigated in Europe amd America and even in India too, by the adoption of measures which it is my purpose to consider in this paper. At one time, it was so very prevalent in England that few men or women could be seen in the streets without pitted marks on their faces which led the poet, Ben Johnson, wail on the ravage on beauty caused by this disease in the following two lines :—

> "Envious and foul disease! could there not be
>
> One beauty in an age and free from thee."

Sir Gilbert Blane told a Committee of the House of Commons that at the end of the 18th century, an adult person who had not had small-pox was scarcely to be met with or heard of, in the United Kingdcm. The frequency of the epidemic as well as its fatal character have been considerably reduced since vaccination and re-vaccination have been generally

enforced in that country.

I am sure, you are all aware, that small-pox has made its appearance in this city and the mortality-statistics of the last few weeks published by the Health Department show that it is increasing and spreading. There was no small-pox in epidemic form in Calcutta in 1914 before the week ending the 28th November. During that week, there were 19 deaths, and the figures for the following 8 weeks are 13, 28, 42, 52, 82, 90, 157 and 155 respectively. Past experience and statistics both point to the fact that small-pox breaks out in this city in an epidemic form every 5th or 6th year, continues so for 2 years, and then remains in a mild form during the interval, although anomalies have now and then been noticed. It generally commences at the end of November, attains its maximum intensity in March and April and then gradually declines. The present year is one of the marked years in the cycle. It is not my purpose here to discuss the theories put forward to explain this peculiar freak of the disease; it is enough for us to know that this is a bad year for small-pox and that we should take extra precautions against its invasion. The table in the next page shows the periodically epidemic character of the disease in Calcutta from 1833 up to the last but one epidemic in 1906, and the present epidemic has broken out just after 5 years.

Small-pox mortality in Calcutta.

Epidemic years.	No. of deaths during epidemic years.	No. of deaths during interval.
1832-33	1614	..
1837-38	917	35
1843-44	1688	44
1849-50	3077	57
1856-57	1648	75
1864-65	2778	52
1874-75	4500	28
1878-79	1138	69
1884-85	317	74
1889-90	485	10
1894-95	1312	24
1900-01	1554	95
1906-07	2095	151

We have learnt with much concern that it has invaded some of our college hostels and messes, and that some of our students have taken the disease. It is a matter serious enough in ordinary times, but it is more so at a time when the University examinations are drawing nigh, when we expect a large concourse of students to assemble in this city from all parts of the province and thus become exposed to the infection. Students living far away, as most of them are, from their parents and relations and deprived of the care and comforts of a home, can not but view with alarm the incidence of the disease among their community, for they know how extremely difficult it would be for them to secure adequate nursing and attendance in their hostels and messes, if they are so unfortunate as to be stricken with this disease. They naturally

look forward for sympathy and help from the many friends and well-wishers of students in this city, and I can assure them that such sympathy and help will not be found wanting.

We are very grateful to the present Vice-Chancellor and the Syndicate of the Calcutta University for the measures they have taken to help the students in their present difficulty. A circular has been sent round to all schools and colleges, hostels and messes, pointing out the necessity of immediate vaccination, and it is believed that the appeal has been largely responded to. The Campbell Hospital authorities have been approached for making special arrangement in the hospital for the accommodation of sufferers among the student class, and we are thankful to the authorities of the Hospital for what they have done in this matter.

The Syndicate also arranged for opening a Students' Nursing Home at 61, Mechuabazar Street, with the co-operation of the Calcutta Sanatorium and undertook to pay the cost of equipment of 10 beds at Rs. 50 per bed. The location of the Home was, however, objected to on sanitary grounds, and this house had to be given up. At the instance of the University, however, the Corporation of Calcutta has opened a hospital for students and poorer middle classes at 12, Seal's Lane, which has been placed under the management of Dr. Y. M. Bose of the Calcutta Sanatorium. Here the students will be treated with all care and

attention under proper sanitary arrangements. Already four students have been received there; one has been discharged cured and the rest are undergoing treatment. It was a great pleasure to me to visit the hospital with Dr. Y. M. Bose, and I was much impressed with the cheerful aspect of the whole place. It is a nice little garden-house with accommodation for 10 patients, with a large open compound all round and open land on all sides beyond the compound. There are four patients now in the hospital; one is cured and will be discharged to-day and two are convalescent; one is still seriously ill, but he is improving. The patients' relations are there to attend on them. There are two trained nurses engaged by the hospital and I was much impressed by the care and attention they were paying to the patients. There is a Resident Medical Officer generally to look after the hospital and he gives medical help whenever required. The patient, of course, can choose his own doctor. The sanitary arrangements are satisfactory and every precaution is taken to prevent the spread of infection. Dr. Bose visits the hospital twice daily. From my personal visit to the place and from my conversation with the patients, I can assure you that any sick student taken to this hospital will be well-cared for and his relations, if they so wish, can stop with the patient. There has not been a single fatal case up to this time in this hospital.

Lastly, Dr. D. P. Sarbadhikari has also arranged to open extra centres of examination in the muffusil to prevent as much as possible the influx of students in this city during the height of the epidemic in March and April next. Our best thanks are, therefore, due to the authorities of the Calcutta University, Calcutta Corporation, Campbell Hospital and the Calcutta Sanatorium for their valuable and prompt help to the student-community at this critical time.

Before I consider the precautionary measures, I should like to speak a few words about the nature and symptoms of the disease. Small-pox is a specific infectious disease attended with fever and characterised by a peculiar eruption on the body. It is believed to be caused by the introduction into the human body of some minute form of parasite of the protoza class which generally sticks to the dry scabs of small-pox eruptions, and these form the principal source of infection. The disease occurs in all climates and attacks persons of all ages, and both sexes equally. It is most fatal to children unless protected by vaccination. The average mortality in Europe among the unvaccinated is about 35 per cent; it is much greater in this country owing to unfavourable sanitary conditions and the crude and unscientific mode of treatment resorted to by most people.

Three forms of small-pox are generally seen. The first is the *true small-pox* occurring

in the unprotected which again is subdivided into the *discrete* and the *confluent* forms. In the discrete form, the eruptions are separate, generally limited in number but may be profuse, and the symptoms and the course of the disease are usually less severe than in the confluent type in which the eruptions are too many, running into one another and forming large swollen patches filled with pus, particularly on the face and the extremities, making the appearance of the patient hideous, his sufferings intense, and his chances of recovery remote.

Another variety is known as the *hæmorrhagic small-pox* in which blood exudes in the eruptions and under the skin, and bleeding also takes place from the internal organs. This is the most severe and intractable form of the disease and it invariably terminates fatally. The countenance of the patient assumes a deep purple or black hue most fearful to look at (hence this form of the disease is called *black small-pox*), the symptoms are most aggravated from the very beginning, and the end usually comes on very rapidly.

The third variety is the small-pox modified by vaccination, i. e., occurring in people who have previously been vaccinated. This is generally a very mild type of the disease, the eruptions are few and far between, the general symptoms much less severe, the course less protracted, and the death-rate very low. It

must be stated here that if the protection by vaccination has been weakened or passed away, the disease may assume a serious character and might run a course almost as severe as in the unprotected. Re-vaccination at a certain age is, therefore, absolutely necessary to keep up the continuity of protection by primary vaccination, but unfortunately, this is too often neglected.

I do not wish to take up your time by describing the various stages of the disease in detail. My object is to give you a brief but clear idea of the disease so that you may be able to recognise it, if it unfortunately attacks any member of the mess in which you live, and thus adopt immediate precautionary measures against the spread of the infection.

Incubation Stage.—In common with other specific infectious diseases, there is a latent period after the introduction of the poison into the body, called the period of incubation, during which the poison multiplies and increases in strength within the body. This period in small-pox is generally twelve days, but it may be a few days more or less. During this period, the patient shows no external signs of the disease.

Initial Stage.—After the expiration of the incubation period, the disease commences with shivering (which may be repeated) followed by a rise of temperature, often 103° F. or 104° F. during the first 24 hours, attended with

headache, severe pain in the back and the limbs, and persistent vomiting. *These symptoms are very suggestive of small-pox during the time of an epidemic.* You must, therefore, be on your guard as soon as you find any person exhibiting these symptoms and you would do well at once to take all precautionary measures against the spread of infection.

Eruptive Stage. Generally on the 3rd day of the fever and sometimes on the 4th day, slightly raised red spots of the size of a pin-head appear first on the forehead and then spread over the face. They have been mistaken for mosquito bites. The redness disappears on pressure, but you generally notice a shotty feel under the finger, as if there is a mustard-seed lodged under the skin. These gradually increase in number in the two following days and spread to other parts of the body, such as the front surface of the wrists, the back, the chest, the arms and the legs. Sometimes, these are preceded by eruptions of a measly or scarlatinal character which are usually limited to the lower abdominal region, the inner surface of the thighs and to the sides of the chest. These may be associated with minute spots of hæmorrhage under the skin. The fever and the other symptoms subside on the appearance of the eruptions and the patient feels easy and comfortable. On the 5th or 6th day, the red spots change into small vesicles with a flat top, depressed in the centre, and a

clear opaline fluid inside. On the 8th day, pus begins to form inside the vesicles, the central depression disappears, the pustules become globular in shape and greyish-yellow in colour. There is much redness around the pustules and the skin between becomes hard and swollen. In severe cases, the pustules run into one another forming large flattened abscesses over the face, the body and the extremities, constituting what is called the CONFLUENT type of small-pox. Bleeding may take place in the pustules giving rise to one of its hæmorrhagic types.

On the 8th day, when pus begins to form in the eruptions, the fever rises again, and in the confluent type, may go up to 105°F. or more. This is called the secondary fever. In the mild cases, the secondary fever is often slight and sometimes absent. With this fever, other symptoms of a dangerous character supervene in bad cases; the face becomes much swollen, sometimes beyond recognition; pulse feeble and frequent; delirium; there may be throat-trouble and difficulty in swallowing owing to formation of pustules in the mouth, throat and the organ of voice. There may be inflammation and formation of pus in the eyes and the patient "presents a terrible picture, unequalled in any other disease; one which fully justifies the horror and fright with which small-pox is associated in the public mind" The danger is in proportion to the number of

eruptions on the face. This is a critical period in the history of a small-pox case, and bad cases generally end fatally at the end of the second week from blood-poisoning and exhaustion.

In favourable cases, the drying up of the pustules begins on the 10th or 11th day, the fever subsides and the patient slowly moves on the path to recovery. The pustules rapidly dry up, first on the face and then on the other parts of the body, and by the 14th or 15th day, dry scales begin to drop off from the face. By the end of the 3rd week, the shedding of the scales is completed. In the confluent type, the scabbing and the shedding of the scales take much a longer time, extending over four or five weeks or more, and the secondary fever with other concommitant symptoms often run a protracted course.

It is during the stage of scabbing and the separation of the scales that the danger of infection is most acute, and *no patient should be allowed to go out and mix with other people until some days have elapsed after the complete separation of the scabs.* In other words, in ordinary mild cases of small-pox, no one should be allowed to leave the hospital or his home and attend school or any place of business at least for 6 weeks from the commencement of the disease.

Complications.—The chief complications are throat-troubles, affections of the lungs,

albumin in the urine, extensive formation of boils during the stage of convalescence and the affections of the eye and the ear. The eye-affections are very common and serious, and unless well-cared for from the beginning, they often lead to permanent loss of sight.

Treatment.—I need hardly trouble you with any reference to the treatment of the disease. I should only mention here that there is a prevailing notion in this country that the English system of medicine is no good in the treatment of small-pox cases. There is hardly any justification for holding this adverse opinion. In most cases occurring in the Indian community, the English system of treatment is not given a fair trial. The mortality from small pox has been brought to a much lower figure in Europe than in India, and there the patient is placed under the modern scientific mode of treatment. It must be understood that small-pox has got no specific treatment. The disease runs its own course. It gives a great shock to the system which must be overcome by gentle, kind and sympathetic management of the case and *expert nursing.* Only the complications have to be guarded against and treated as they arise, and the spread of infection to be prevented by hygienic measures. It can not be denied that this could best be done by the Western system of treatment.

Precautionary Measures.—It is now my purpose to refer briefly to the measures which should be adopted, not only to prevent the incidence of small-pox but also to check its spread when unfortunately it has appeared in a community. Infectious diseases, as a rule, generally occur once only in the life-time of a man, but a second or even a third incidence in the case of some of the infectious diseases is not unknown. In the case of small-pox, the victim is practically protected from the disease for the rest of his life, although rare cases of second or even third attacks of small-pox are known. As mortality from small-pox was very heavy, and as people saw that second attacks of small-pox were rare, it naturally occurred to the intelligent men of the community that if, by any means, a mild type of the disease could be developed in the system, immunity from the disease might be obtained. This led to the practice of *inoculation* which consisted in the introduction of a small quantity of the poison from a very mild case of small-pox into healthy individuals and this generally produced mild types of genuine small-pox in the inoculated, and was found to give protection from the disease for life in very many cases. This practice of inoculation was known in India from a very remote age and was practised all over the country until it was suppressed by law in 1865 and its place taken up by *vaccination*. In England inoculation was in-

troduced in 1726 by Lady Mary Wortley Montague who learnt the art in Constantinople, and as the mortality from small-pox was very high in England at that time, she introduced the system and brought down the mortality from over 35 per cent in the unprotected to 2 or 3 per cent in the inoculated.

There were, however, grave objections to the practice of inoculation. In the first place, it meant the *introduction of the virus of true small-pox into the healthy body* which often developed a serious form of the disease, not infrequently ending fatally. Then again, it created fresh focus of infection and thus helped the spread of the disease and was responsible for frequent outbreaks of the epidemic. When the immortal JENNER discovered that the operation of *vaccination* practically gave life-long protection against small-pox, people gradually replaced the dangerous practice of inoculation by the simple harmless operation of vaccination, and in 1840, inoculation was prohibited by an Act of Parliament in England, and in 1865, it was also suppressed in Calcutta.

In 1765, when Jenner was an apprentice to a Surgeon in Gloucestershire, a young woman came to the Surgery for advice and incidentally mentioned that she was proof against small-pox, as she had contracted a disease, called cow-pox, which affected the cows. This statement produced a deep impression in young

Jenner's mind and when he became a doctor, he began to think over the matter and carried on laborious investigations to find out the truth. In May, 1796, a dairy-maid had cow-pox and Jenner took the lymph from her and introduced it into body of a healthy boy. A month and a half after, Jenner inoculated this boy whith *the virus of true small-pox*, but he did not develop the disease. Similar further experiments fully established Jenner's claim that cow-pox, developed in man, was an absolute protection against small-pox. It is now generally agreed that cow-pox is really human small-pox modified by its passage through the cow. A Committee was appointed to enquire into the truth of Jenner's epoch-making discovery and they confirmed his conclusion. The crucial experiment carried in Boston in 1802 fully justified Jenner's conclusion that "cow-pox was a complete security against the small-pox". Eighteen boys were inoculated with the cow-pox. Sometime after, twelve of them were inoculated with small-pox; none of them showed the disease. A control experiment was made by inserting the same small-pox poison into two un-vaccinated boys with the result that both took the disease. The eighteen children were again inoculated with the virus of small-pox which the two boys had developed, with negative results. No further proof was needed to establish the protective power of vaccination against small-pox.

If small-pox has been described as "the greatest scourge which has affected the humanity," *vaccination* is undoubtedly "the greatest boon that Science has conferred upon humanity," and Jenner who discovered it, is truly one of the greatest benefactors of the human race.

The first and foremost precautionary measure against small-pox, therefore, is *vaccination* and *vaccination only*.

We do not know of any prophylactic medicines which would prevent the incidence of small-pox. Sanitary measures, even when properly carried out, would not alone be sufficient to check the spread of the infection without the help of vaccination carried on simultaneously, once the disease has made its appearance in an unprotected community. It is a pity that, after a most successful trial in the different countries of the world extending over more than 100 years, there should still arise any necessity for advocating the cause of vaccination among the educated public. Unfortunately, there are people well-advanced in education and public spirit who do not believe in the protective power of vaccination. There are some people in England who refuse vaccination as being hurtful to the liberty of conscience, and there are hundreds and thousands in this country who avoid it through ignorance and prejudice or on religious and supertitious

grounds. This attitude of the people is responsible for the frequent out-breaks of the epidemic in this country.

I am now going to place before you some reliable statistics, both foreign and Indian, which, I am sure, will convince you of the following facts regarding vaccination :—

(1) That vaccination gives the greatest amount of protection, if not absolute immunity, from small-pox and that the operation is attended with no risk whatever.

(2) That vaccination has not only reduced the incidence of the disease, but also the mortality from it all over the world.

(3) That in a mixed population of the vaccinated and unvaccinated, it is the unvaccinated that suffer much more extensively from small-pox and die in much larger number than the vaccinated.

(4) That in the only country where re-vaccination is compulsory, small-pox has been practically suppressed.

The decline of small-pox mortality in some of the countries in Europe, after the introduction of vaccination, is strikingly shown in the table (abridged) in the next page prepared by Sir John Simon :—

Territory.	Approximate average annual death-rate by small-pox per million of living population.	
	Before introduction of vaccination.	After introduction of vaccination.
Austria ..	2484	340
Trieste ..	14046	182
Bohemia ..	2174	215
Moravia ..	5402	255
Silesia	5812	198
Brandenburg ..	2181	181
Westphalia ..	2643	114
Berlin	3422	176
Sweden ..	2050	158
Copenhagen ..	3128	286

The table below gives the average annual death-rate from small-pox per million of population in London before and after the introduction of vaccination; it was introduced in London between 1801 and 1810 and made compulsory in 1871.

Years.	Average annual death per million.
From 1728-57	4260
From 1801-10	2010
From 1831-35	830
From 1838-53	513
From 1854-71	388
From 1872-90	178

Dr. Abbot's table (abridged) shows the difference of death-rate from small-pox among the unvaccinated and the vaccinated in the different countries of Europe and America:—

Places.	Death-rate per 100 cases.	
	Among the unvaccinated	Among the vaccinated.
France	16.1	1.0
Quebec	27.0	1.7
Verona	46.5	5.6
Milan	38.5	7.6
Breslau	53.8	2.1
London Small-Pox Hospital ..	35.0	7.1
Malta	21.1	4.2
Illinois	48.6	6.1

The Philadelphia figures are most striking. Of 2831 unprotected cases admitted into the Municipal Hospital, 1534 died, i.e., 54.18 per cent. 2169 cases of small-pox among the protected were admitted and the number of deaths was 28 only, i.e 1.2 per cent.

Vaccination was made compulsory in Calcutta in 1880. The mean ratio of deaths per 100,000 of the population per annum for 19 years previous to this was 116.8, and for 19 years subsequent was 44.5.

In Madras where vaccination was made compulsory in 1884, the result was as follows :—

Years	Mean ratio per annum.
1874-84	42 per 1,00,000.
1885-94	6 per 1,00,000.

Since the introduction of compulsory vaccination in England, the death-rate from small-pox has been reduced from 100 per 1000 of the population (i. e., $\frac{1}{10}$) to 10 per 1000 (i. e., $\frac{1}{100}$). The average death-rate from small-pox in England in the 19th century was not more than 3 or 4 per every 1000 persons. During 10 years (1881-1890), the average death-rate in England was .05 per 1000 of the population. This is a marvellous result achieved by the introduction of compulsory vaccination.

In the Sheffield epidemic of 1887-88, Dr. Barry collected the statistics and found that while 17.2 per cent. of the attacks were severe among those vaccinated, 81 per cent. were severe among the unvaccinated; and in children under 10 years, 9 per cent. of the attacks were severe among those vaccinated and 78 per cent. among those unvaccinated; that of 268397 vaccinated persons, only 1.5 per cent. were attacked with small-pox and .07 per cent. died; whilst of 5715 unvaccinated, 9.7 per

cent. were attacked and 4.8 per cent died (i.e., 50 per cent. mortality).

From the report of the Vaccination Committee of the Epidemiological Society, it will be seen that of the 734 nurses and attendants in the Metropolitan Asylum Boards Hospital for Small-pox, there were 79 who had small-pox previously and none of them was infected; 645 had been re-vaccinated before entering on their duties and the whole of these escaped the disease; the remaining 10 had not been re-vaccinated, and *every one of them took small-pox.*

In the present epidemic of Calcutta, I know a few instances where only the unvaccinated members in the family took the disease and died of it, while the rest of the family who were vaccinated, escaped it. In a doctor's family, the vaccination of two boys aged 6 and 2 years respectively was unfortunately neglected. The older boy contracted small-pox and died on the 13th day of the disease. On the appearance of small-pox in this case, the other child was hurriedly vaccinated, but unfortunately it was too late; the child took the small-pox on the 5th day of vaccination and succumbed to it. He had evidently imbibed the small-pox poison at least a week before vaccination was done.

In regard to this point, Parkes and Kenwood observe that it is probable that if vaccination is performed on a person who has

already contracted samll-pox, *within 48 hours of the exposure to contagion*, vaccinia ensues, and *small-pox is avoided.* But if performed at a later date, *small-pox is contracted, modified if within three days but unmodified if later,* with vaccinia possibly running its own course at the same time.

I know another family of a doctor who did not believe in vaccination and the children in the house grew up without it. At the last epidemic, one of his grandsons (a young man of 17) suffered severely from confluent small-pox but he ultimately recovered. During the present epidemic, another grandson (aged 29) has got it and is passing through a critical period.*

Dr. Sundari Mohan Das, M.B., in his book on "Small-Pox and Vaccination," cites a few cases from personal knowledge showing the protective influence of vaccination upon small-pox. I quote here one case only. At Barnagore, a few miles north of Calcutta, small-pox appeared in the house of a rich merchant, an anti-vaccinationist. His family consisted of 14, of whom the three daughters-in-law only, born and bred in Calcutta, were vaccinated. *The unprotected eleven were all attacked and four died.* Of the protected three who had been nursing their sick husbands and children, one only had a very mild attack

* The young man has since died of the disease.

of modified small-pox and recovered within 12 days.

I could cite a number of such striking cases, but I do not wish to unnecessarily swell up the volume of my paper.

Osler observes that susceptibility to re-vaccination is very general. In 1891-92, vaccination pustules developed in 88.7 per cent. of the newly-enrolled troops of the German Army, most of whom had been vaccinated twice in their lives before. He further observes that communities in which vaccination and re-vaccination are persistently neglected are those in which epidemics are most prevalent. As an illustration, he mentions that, owing to a widespread prejudice against vaccination and re-vaccination in Montreal, there grew up, between the years 1876 and 1884, a considerable unprotected population, and the materials were ripe for an extensive epidemic. The soil had been prepared and it only needed the introduction of the seed which, in due time, came with the Pullman car conductor from Chicago on the 28th February, 1885. Within the next 10 months, thousands of persons were stricken with the disease and 3164 persons died.

Dr. S. M. Das, who was for many years a Medical Officer to the Calcutta Corporation had great opportunity to study small-pox cases during several epidemics in Calcutta. About the incidence of the disease among the

protected and the unprotected, he says that from April to June 1896, out of 944 persons exposed to infection that came under his personal knowledge, 683 were vaccinated, 99 inoculated, 36 pitted (having had a previous attack of small-pox) and 126 unprotected. The percentage of attack among the vaccinated was 2.9; among the inoculated 10.1; among the unprotected, 82.5, and among the pitted, nil. He further observes that in 34 years from 1832 to 1865 when inoculation was in vogue, the number of deaths from small-pox was 24513, while in 34 years after the prohibition of inoculation, the number fell to 8785 or nearly one-third.

From the above statement, it will be seen that inoculation, which is popularly believed to be a sure protection against small-pox, is hardly deserving of the credit given to it.

Vaccination may be unsuccessful owing to already existing protection, or to bad lymph, or careless or unskilful operation. The simple scratching of a person's arms and applying a fluid from a sealed tube thereon is not all that constitutes successful vaccination. Unsuccessful vaccination leads to great mischief, as it gives a false hope of security to the person operated upon, and if he gets small-pox, vaccination is discredited and the number of the unvaccinated in the community increases. The necessity for successful vaccination can not, therefore, be too seriously urged. It should be done by properly trained persons,

and its effects carefully watched. Unless the characteristic vesicles develop with well-marked areola round them, maturing on the 8th day with constitutional disturbances, and the crust separating in the 3rd week, the operation can not be accepted as successful and should be followed by a second operation. It is doubtful if any child is proof against primary vaccination; non-appearance of vesicles in primary vaccination, therefore, indicates unsuccessful operation and it should be repeated. In re-vaccination, the vesicles are smaller, the areola less marked, and the constitutional disturbance slight or usually absent; this operation may prove unsuccessful owing to latent protection in the system. In times of epidemic, however, if re-vaccination is unsuccessful it should be repeated to make sure of the existing protection. Sometimes, a spurious vesicle develops in re-vaccination; this dries up on the 8th or 9th day; this should not be taken as successful vaccination. In primary vaccination, there should be at least 4 points, and for re-vaccination, two points are quite sufficient. There is a direct relation between the number and character of the vaccination-marks in an individual and the chance of his getting small-pox. The larger the number of scars and the more well-defined they are, the less liable is the person to the attack of the disease. The following statistics of 20 years from cases treated in the London Small-Pox

Hospital clearly demonstrate this point :—

	With 1 mark.	With 2 marks.	With 3 marks.	With 4 marks.	With no marks but said to have been vaccinated.
No. of admissions	2001	1446	518	544	370
Percentage of mortality ..	7.73	4.70	1.95	0 55	23.57

Nothing could be more convincing than the above figures of the undoubted protection afforded to persons having 4 well-marked vaccination-scars.

The chief objection against vaccination is that it may transmit certain diseases such as syphilis, tuberculosis, leprosy etc., through infected lymph. Very careful investigations have proved beyond doubt that if calf-lymph is used for vaccination (as is universally done now), there is not the remotest chance of communicating any disease through vaccination. Syphilis, leprosy etc., never occur in the cow and the freedom from tuberculosis is experimentally ascertained before the calves are used for purposes of vaccination. The calf-lymph may be taken directly from the calf, or it is preserved mixed with glycerine in sealed capillary tubes, or in lanolin, for convenience of transit. Repeated trials have shown that the lymph supplied by the Health Department of Calcutta is quite trustworthy. Lymph

undergoes deterioration by exposure to heat. It is, therefore, kept in a refrigerating chamber and removed when needed. In this country, it should be quickly consumed after removal from the ice-chamber. In the ordinary temperature of Bengal, it may keep good for a week in the cold weather, and for two or three days in the hot weather.

Re-vaccination should be made compulsory in every country, at least once at or about the age of puberty. Winter Blythe observes that if re-vaccination is performed every 7th year, small-pox may altogether be stamped out from a community. Both experience and statistics confirm his view in the matter. The only country in Europe where re-vaccination is compulsory is Germany, and there is no country in the world which enjoys a greater immunity from small-pox than Germany. Primary vaccination must be done in Germany within the first two years of life; re-vaccination is done at the end of the compulsory school period, and a third operation is done when the young man joins the army. In the case of women, only one re-vaccination is compulsory. It is significant to note that the few cases of small-pox that occurred in that country between 1886 and 1890 were in children under 2 years of age. If primary vaccination is made compulsory in Germany within a few months after birth, probably even such few cases will not occur. It is stated that in the Prussian Army, there

had not been a single death from small-pox from 1874 to 1901 for which statistics have been collected.

Next to vaccination, *isolation* of the patient is the most important measure to be adopted to prevent the spread of infection. In every hostel and mess, therefore, a room with sufficient light and ventilation, preferably situated in a separate block or on the highest storey of the building, as far distant from the rooms of the other boarders as possible, should be kept apart for the accommodation of any suspected case, and the admission of any person into the sick-room except those that will have to tend the patient should be strictly prohibited. There should be two attendants working alternately in the sick-room. The lavatory arrangements should be separate and all discharges of the patient should be thoroughly disinfected before disposal. It is best to have them burnt, if possible. As soon as the disease is correctly diagnosed, the patient should at once be removed to a Hospital or Nursing Home, and the room, the furniture and the articles used by the patient should be thoroughly disinfected. There is no trouble in the matter, as the Health Department will do it on receipt of information. So long as the patient remains in that room, his attendants should not be allowed to do general duty in the hostel and they should wash their hands and feet with some disinfectant and change their clothes whenever

they have occasion to go out. No food or drink should be taken by the attendants in the sick-room. The clothes and beddings should not be sent to the *dhobi* without being disinfected; prolonged boiling in water would generally suffice. If any outsider wishes to visit the patient, he should not be allowed to do so if he has not been recently vaccinated, and he should leave his ordinary clothes outside and put on a mantle specially kept for the purpose of visiting the sick-room. There should be barely necessary furniture in the patient's room and all utensils etc., should be thoroughly disinfected before and after use. The drains and sewers of the house should be daily flushed with some kind of disinfectant.

Notification of the disease to the sanitary authorities is another important factor to check its spread. As soon as the disease is diagnosed, a notice should be sent to the Health Officer who would hold immediate enquiry as to the presence of any other case in the neighbourhood, arrange for the conveyance of the patient in special ambulance-cars to hospital, and take all necessary steps for the disinfection of the house, the vaccination of its inmates, and improving the general sanitation of the locality. In Calcutta, notification of infectious diseases has not yet been made compulsory. Experience has shown that if early notice is received, an epidemic may be successfully grappled with and nipped in the bud by the careful manage-

ment of the few cases at the commencement, but once it has suffered to grow, it spreads like wild fire and then, any amount of sanitary meaures is powerless to check its course.

Quarantine and *Disinfection*, if properly carried, are great factors in the suppression of an epidemic. When a small-pox case has occurred in a hostel, it is best to remove, where possible, all other inmates to a separate house and have them vaccinated, but no one should be permitted to go to his home or native village, or attend school or a place of business at least for 2 weeks, as he might thus carry the infection to new centres, the infection of small-pox being communicable from the very commencement of the disease. If the case is treated in the house, the inmates of the infected house should not go out and mix with other people for at least 6 weeks. During this period, attendance at school and places of business should be prohibited. This step will no doubt inconvenience the students as regards keeping the necessary percentage of attendance in their lectures, but this must be done as it is a well-known fact that infection is very often caught at school. I am sure the students will have the good sense to follow this advice for the safety of others.

As in England, there should be a code of rules here, prescribed by the Education Department, for the prevention of infectious and contagious diseases in schools. It should be

in force in all schools and colleges and should indicate the day on which a boy or girl may usually return to school after suffering from, or being exposed to, infectious or contagious disease. It should be made incumbent on the parents, guardians and superintendents of hostels and messes to report to the College or School authorities the occurrence of every case of infectious disease in the residence of the student; the failure to report such cases should be severely dealt with. When the student returns to school, he should produce a medical certificate stating that, in the opinion of the medical officer, he is free from infection.

On recovery, the patient should not be allowed to mix with other people until the scabs have completely separated. *It should be remembered that the time when the scabs are separating is the most infecting period of small-pox* and extreme care should be taken to prevent healthy people to come in contact with the patient at this stage. There should be free application of some antiseptic preparation over the whole body of the patient to prevent scabs mixing with the air and carried from place to place. It unfortunately often happens, however, that as soon as the acute symptoms subside, and before the complete separation of the scabs, the patient covers himself with an extra supply of clothes to avoid detection by Railway authorities and quietly goes to his native village, only to infect other people

there. This is the most common way of spreading the disease to new centres and should be firmly prevented.

Ordinary clothes and beddings used by the patient should be destroyed by fire. Strict orders should be passed on the Registrars of *burning ghats* to see that all the beddings and clothes taken with the dead body are burnt then and there, and not taken by the *domes* who trade on them and thereby cause dissemination of the infection. Valuable clothes may be disinfected by prolonged boiling in water, or in special apparatus by steam.

For disinfecting hands, utensils etc., a five per cent carbolic lotion in water is good. For washing the floor and walls of the sick-room, 1 in 1000 perchloride of mercury lotion will serve the purpose. The room should further be disinfected with formalin vapour, and afterwards, freshly lime-washed. For disinfecting drains etc., cyllin or phenyle (1 part in 20 parts of water) may be used.*

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* This was a lecture delivered at a meeting at the Y. M. C. A., 86, College Street, Calcutta, on the 16th February, 1915.—EDITOR.

III

MEDICO-LEGAL.

Deposit of Yellow Arsenic on the Endocardium in a case of Arsenical Poisoning

The following case of arsenical poisoning presents some very interesting features of *medicolegal* importance, and this may be considered a sufficient apology for the publication of this paper.

HISTORY.—It may be worthwhile to narrate the history of the case. A parcel consisting of a wooden box reached Howrah from Patna in August, 1891, addressed to some person in Calcutta. It remained unclaimed for some time. Having noticed a dark coloured offensive liquid issuing from the box, the railway authorities had the parcel opened, and the corpse of a young Mahommedan woman was found in it. The body in due course was sent to the Civil Surgeon, Howrah, for autopsy and report.

The Civil Surgeon forwarded the stomach with a portion of liver, the heart and portions of large intestines separately in three glass bottles for chemical analysis. He suspected it was a case of arsenical poisoning, and drew the

* Indian Medical Gazette, May, 1892.

attention of the Chemical Examiner to a "peculiar bright yellow deposit on the endocardial lining of the left ventricle."

CONDITIONS OF THE VISCERA.—The stomach as received in the Chemical Examiner's office was found cut open, and although it had been lying immersed in spirit for some time, patches of congestion could still be discerned; the congested spots, as well as other parts of the mucous membrane, were covered over with a layer of mucus mixed with fine dirty-white particles. The appearance was characteristic of Arsenic poisoning. The Civil Surgeon reported the stomach to be normal in size, deeply congested, containing bloody fluid with mucus and flocculent matter.

The mucous coat of the portions of large intestine forwarded for analysis, was found covered in patches with a yellow deposit like yellow sulphide of arsenic. At the *post-mortem*, the mucous membrane of the large intestine was noticed to be swollen and congested, containing a yellow fluid emitting no fœcal odour. *The most important post-mortem appearance*, however, which forms the subject of this paper was the peculiar staining of portions of the endocardium lining the ventricles of the heart.

The heart as received by me was found cut open and its cavities exposed. There was nothing particular to note in the general appearance of the organ.

There were bright yellow stains on the internal surfaces of both the ventricles. In the left ventricle, the yellow patch extended from the apex of the heart upwards running parallel and close to the posterior border of the septum ventriculum to about half an inch below the insertion of the mitral valve, and then curving downwards to a point half an inch above the apex. The long arm of this arch measured about 1.9 inches; it was nearly of an uniform breadth throughout, measuring between three-fourth to half an inch except the free end of the short arm which was found tapering.

In the right ventricle, the yellow patch was of an irregular square shape touching the apex of the heart with one of its sides, each side of the square measuring about 1.125 inches.

The endocardium lining the smaller musculi papillaris and columnæ carnæ was affected, the muscle substance being free from infiltration with any yellow particles. The endocardium lining the larger musculi papillaris as well as other parts of the ventricles, the auricles, the valves and vessels entering into and issuing from the heart was free from yellow deposit.

In the *post-mortem* report, the yellow stain was mentioned to have been detected in the left ventricle only, and the heart was described as soft from decomposition and containing no *ante* or *post-mortem* clots. Whether the yellow

stain in the right ventricle developed subsequent to the *post-mortem* examination, or that it escaped the notice of the officer who conducted the autopsy, cannot be definitely ascertained.

OTHER POST-MORTEM APPEARANCES.—The lungs were reported to be collapsed, of a dark-purple colour, firm like liver and to float heavily; the mucous membrane of the larynx was deeply congested.

The spleen was healthy; the peritoneum and the kidneys were congested.

There was "marked absence of the ordinary putrid odour generally, and no fœcal odour from the intestines."

The body was in an advanced stage of decomposition and the face was disfigured.

RESULTS OF CHEMICAL ANALYSIS.—The fine dirty-white substance in the stomach was found to be composed of particles of white arsenic. The yellow patches in the large intestines were found to contain arsenic (yellow sulphide) by Reinch's test.

Portions of endocardium bearing the yellow stains were detatched, washed well with distilled water and submitted to Reinch's test; well-marked crystals of arsenic trioxide were detected.

Another portion of the well-washed stained endocardium was treated on a watch glass with a few drops of a 10 per cent. solution of caustic soda; the yellow stain immediately

disappeared; the alkaline solution when treated with a slight excess of dilute hydrochloric acid threw down a yellow precipitate which was sulphide of arsenic. These tests conclusively show that the stain on the endocardium was caused by the deposit of yellow arsenic.

Arsenic was detected in the substance of the heart by Reinch's test.

REMARKS.—In cases of poisoning by white arsenic, yellow patches are sometimes discovered on the mucous coat of the stomach and the intestines as were noticed in this case too in the large intestine; these are usually referred to the formation of tri-sulphide of arsenic. *But such deposits, as far as I am aware, have not hitherto been observed in the heart.*

It is reasonable to suppose that the yellow deposit in the heart was due to the action of sulphuretted hydrogen generated during putrefaction on the arsenic deposited in the tissues; but it is difficult to account for the irregular distribution of the sulphide.

It is possible that arsenic may not be uniformly distributed throughout the structure of the heart, but that certain portions possess greater power for retaining arsenic than others. It is well known that in cases of arsenical poisoning, the element is not uniformly distributed throughout the structure of the liver

EXPERIMENT (*Results negative*).—In order to test this point, a cat was poisoned with arsenic, and two days after death, the heart was removed, cut open, rapidly washed to remove adherent clots and then immersed in an aqueous solution of sulphuretted hydrogen. The results as regards the unequal distribution of arsenic were negative.

The experiment is to be continued and the results published in due course.

Surgeon-Captain J. F. Evans, M.B., I.M.S.

Chemical Examiner, Bengal, 1893—1895.

To face page 207.

The Necessity for an Act Restricting the Free Sale of Poisons in Bengal.*

A very large number of cases of poisoning occur annually in Bengal, and as none of the safeguards against their occurrence in vogue in England and other European countries exist in Bengal, it naturally suggests itself whether, considering the difference of population, the number of cases of poisoning is excessive; and, secondly, whether the number of cases of poisoning is capable of reduction. Throughout the length and breadth of India, except in Bombay, the sale of poisons is absolutely free and unrestricted. Arsenic, aconite root, nux vomica seeds and other deadly poisons may be bought by man or woman in almost any quantity and without question. Many potent poisons, such as datura, oleander, grow wild or almost so in many parts of India, so that any measure prohibiting the possession of such poisons would be very

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*By Surgeon-Captain J. F. Evans, M.B., I.M.S., and Chunilal Bose M.B., F.C.S., Chemical Examiners to the Government of Bengal.

Transactions of the First Indian Medical Congress, 1895.

difficult to enforce. The drugs, however, most frequently used as poisons do not grow wild, but can be easily purchased in any bazar in India.

In the population of every country, there are some with criminal instincts ready to turn to account any opportunity that exists for the committal of crime. It is individuals of this class, who, by association and habit of life, would come to learn the nature and appreciate the use of a poison. So long then as criminals exist, the free traffic in poisonous drugs is attended with very considerable danger to the population in general. This being so, the necessity of placing the sale of poisons under legal restrictions has often been represented to Government by those well qualified to speak with authority on the subject. Government has, however, hitherto declined to take action in the matter, and on several occasions, has assigned definite reasons for declining to take action. Admittedly, on all hands, the restriction of the sale of poisons in India is by no means so simple and easy as in England. Certain difficulties are self-evident, and these have apparently strongly influenced Government in its decision. Our object in bringing the matter before the Medical Congress is to invite discussion in the hope that some feasible plan of dealing with an admitted evil may be evolved. The reason for particularising Bengal as the subject of our paper is, *firstly*, that there is already in existence

a Poison Act in Bombay; and, *secondly*, that complete statistics with regard to other provinces are not available. However, the few statistics that we have been able to collect with regard to the prevalence of the crime of poisoning in other provinces unmistakably show that what is true for Bengal is also true for her sister presidencies. In our opinion, it is not only possible to restrict the free sale of poisons, but we believe also, that such restrictions will be followed by a permanent diminution of crime. We are supported in this belief by the opinions of many persons who have devoted considerable attention to the matter.

From natural and other causes peculiar to India, the subject has many bearings. These can best be considered under the different sections into which our paper is divided. We have arranged the matter treated in our paper under the following heads:—

A.—Prevalence of poisoning in Bengal as compared with England and the necessity for accurate statistics regarding cases of poisoning in Bengal;

B.—Nature of the poisoning which occurs in the province of Bengal;

C.—Measures proposed with the object of restricting the free sale of poisons.

A.—*Prevalence of poisoning.* The prevalence of poisoning can only be judged from the number of cases of fatal and non-fatal

poisoning annually reported. At the present time in the province of Bengal, no report is available regarding the total annual number either of fatal or non-fatal cases of poisoning. The Police Administration Reports deal naturally with criminal poisoning only, and contain no reference to instances of accidental poisoning. The Chemical Examiner's Report is simply the record of the results of the chemical examination of viscera, vomited matters, and other articles that may be referred for examination. It does not profess to be a return even of total suspected cases of poisoning, and affords no information as to the nature of the cases whether fatal or non-fatal, and, if fatal, whether suicidal, accidental, or homicidal. The Report of the Health Officer of Calcutta and the Calcutta Police Administration Return deal with fatal cases of poisoning more in detail, but have reference only to Calcutta and its suburbs.

English statistics divide fatal cases of poisoning into *murder by poison, suicide,* and *accidental death from poison.* The latest English statistics which we have been able to obtain, refer to the five years, 1876 to 1880. During this period, there occurred 12 cases of murder by poison, 642 cases of suicide by poison, and 927 cases of death from accidental poisoning. Let us first deal with the crime of murder by poison. As just stated, 12 cases occurred in England during the five years, 1876 to 1880, or an average of .07 per million of the population in each year. During

the same period of time in Bengal, the Police Administration Report shows that 94 cases of murder by poison occurred, or an average of .31 per million in each year. Accordingly, for the period under reference, the crime of murdur by poison was rather more than four times more prevalent in Bengal than in England. The Police Administration Reports for the last five years, *viz.* 1889 to 1893, show a slight reduction in the number of cases of mudrer by poison, 81 cases having occurred, or an average of .23 per million of the population. The crime is, therefore, still three times more prevalent in Bengal than in England.

It is admissible, we think, to refer here to the nature of the scientific evidence on which the charge of poisoning rests. First in importance is the evidence of the doctor who has treated the sick man, and that of the medical man who has made the *post-mortem* examination. Next comes the result of the chemical examination of viscera, vomited matters, stomach washings, etc. Chemical examination is often negative for many reasons ; the poison may have been absorbed and destroyed in the organs of the body ; it may have been voided by vomiting and the vomited matters lost, or it may have been removed by prompt remedial measures. It is partly on this account that in an enquiry as to the prevalance of poisoning that the Chemical Examiner's reports afford so little assistance. There is also another reason why the Chemical Examiner's reports are

incomplete. In many instances, where the medical officer holding the *post-mortem* examination finds a sufficient quantity of recognizable poison in the stomach to enable him to give a positive opinion as to the cause of death, the cases are never referred to the Chemical Examiner at all. We do not suppose this is ever done in cases of suspected murder by poison, at least it ought not to be; but it does take place in cases of suicide, the prevalence of which class of poisoning we now pass to consider.

As already stated, the English statistics for the five years, 1876 to 1880, show that 642 cases of suicide by poisoning occurred or 3.55 per million of the population in each year. In Bengal, the report of the Sanitary Commissioner shows that the total number of suicides from all causes occurring in the province during this period was 11,662 or 38.8 per million of population per annum. For the last five years, the numbers are 15,743, or 45.8 per million per annum. The number of suicides from all causes occurring in England and Wales in the year 1875 gives an average of 65.2 per million of the population. So far then as can be ascertained, suicide is less frequent in India than in England. We are, however, more concerned with the methods of suicide as practised in the two countries. In England, suicide by poison constitutes about 12.25 per cent. of the total cases of suicide, giving as stated above an incidence of suicide by poisoning equivalent to 3.55 per million of the popula-

tion per annum. We regret to say that no returns are available for the whole province of Bengal to show what proportion of the suicides is due to violence and what to poison; nor are all the cases of suspected suicide by poisoning that occur referred to the Chemical Examiner. Thus Surgeon-Major J. B. Gibbons, Police Surgeon of Calcutta, informs us that out of 44 cases of suicide by opium examined by him in the year, 1st June 1893 to 1st June 1894, he sent only 18 cases to the Chemical Examiner. In the remaining 26 cases, there was a sufficient quantity of opium in the stomach to enable him to ascribe the deaths to the action of the poison without the help of chemical analysis.

We are not, however, without some data as to the incidence of suicide by poisoning in Bengal. For the reports of the Commissioner of Police of Calcutta afford much more accurate information regarding the occurrence of suicide by poison in the town and suburbs of Calcutta than is available for the rest of the province. Thus, during the five years, 1876 to 1880, 126 cases occurred, or an average of 36.42 per million per annum. For the five years, 1889 to 1893, 236 cases occurred or an annual average of 68.84 per million. Of these cases, 23 were due to arsenic, 167 to opium, and 46 to other poisons. Of the total cases of suicide in the town and suburbs of Calcutta, 55.8 per cent. were due to poison as against 12.25 per cent. in England. These figures also show that suicide by means of

poison is about nineteen times more prevalent among the population of the town of Calcutta than it is generally among the popualtion of England.

Is there any reason to suppose that suicide by poison is more prevalent in the large towns of Bengal like Calcutta than in rural districts, or may the state of affairs in Calcutta be taken as representing the conditions existing generally throughout the province? There is nothing in the availab'e statistics to warrant the latter conclusion, and there is, on the other hand, the well-recognized fact that the conditions of life in large and wealthy cities are prone to develop those mental, social and physical states which frequently prompt self-destruction. Painless methods of self-destruction are preferable to painful methods, and it is in large towns that a knowledge of the painless methods of ending life would most easily be acquired, and the drugs selected for the purpose be most casily procured. It is possible, however, that a considerable number of cases of suicide by poison occur in rural districts that are never reported to the police, or brought to light in any way. Instances of suicide also occurring in the families of respectable and influential individuals are, no doubt, often secretly disposed of to avoid scandal. At the present time then, the available statistics afford no information as to what proportion of the total suicides occurring in the province are due to violent methods and

what proportion to the use of poison. Some facts are, however, available, which go to show that, not only has suicide increased to an alarming extent in the large towns, but that the use of poison has a great deal to do with the increase that has taken place. Hanging and drowning were the methods of self-destruction chiefly selected a quarter of a century ago. To-day in the town of Calcutta, more than half the cases of suicide are due to poison—a great contrast to the conditions existing half a century ago. For in the year 1850, of 21 cases of suicide occurring in Calcutta, 4 or about 20 per cent., were caused by poison, the remainder by hanging and drowning. During the year 1856, according to Dr. Woodford, then Police Surgeon of Calcutta, the proportion of suicide was 1 to 2,000 of the population of the town. The proportion of suicides to the population in the town of Calcutta, exclusive of suburbs, is now 1 to 1,300, this being the average annual incidence during the last six years. These figures show a truly alarming increase in the crime of self-destruction in the municipal area of Calcutta, and become even more significant from the fact that poison now accounts for 70 per cent. of the suicides as against 20 per cent. in 1850. In 1865, Dr. Beatson reported the occurrence of 41 cases of suicide at Dacca. Of these, one only was due to poison, 38 to hanging, and the remainder to drowning. It will be noted that the statistics, which we are able to

quote, refer to only one large town in the province. Further, that these statistics are advanced as evidence of the necessity for new legislative measures. It may legitimately be pointed out that legislation, the necessity for which is based on the condition in one large town of a province with a population of 70,000, 000, may not be required in the rest of the province. To this we would reply that the existing conditions regarding the sale of poisons, although possibly not productive of a large crop of suicides by poison in the rural districts, undoubtedly produce in the rural districts a great deal of other crime to which we shall subsequently refer. Further, it will be seen that the measures proposed chiefly affect the large towns.

The conditions of life in all the large towns of the province, if not exactly similar, at any rate approximate to those attending life in Calcutta. At the present time outside Calcutta but little is accurately known about the conditions existing in the rest of the province as regards the crime of self-destruction, nor is it probable that reliable information will be forthcoming, so long as the dead may be disposed of by cremation or burial without a medical certificate as to the cause of death. Naturally, it would be preposterous in rural districts to require a medical certificate as to the cause of death before a dead body could be disposed of.

It is far otherwise, however, in large towns, where medical advice is plentiful, and the dead are disposed of in regular authorized places under police control. The enactment of such a measure should form the initial step. Its operation in large towns would be distinctly beneficial, enabling the authorities to estimate the amount of crime and guage the benefits or otherwise derived from legislative measures for its repression. The value and accuracy of returns relating to the prevalence and fatal nature of disease would also be largely enhanced by such a measure. It is in large towns also that deaths by poisoning of a non-criminal nature chiefly occur. For the welfare of the community, it is highly important that Government should be able to ascertain the number of such deaths. But so long as the dead can be diposed of without medical certificates, the accurate registration of the cause of death is quite impossible.

Death by poisoning of a non-criminal kind is usually described as death from accidental poisoning. Of such deaths, 927 or 5.15 per million per annum, occurred in England during the five years, 1876 to 1880. It is highly improbable that anything like this number occurs annually in Bengal. The population is for the most part agricultural, and unlikely to handle poisons with the appearance of which they are unacquainted. In the large towns, however, notably in Calcutta, a certain number of deaths

from accidental poisoning occur annually. Thus in the municipal area of Calcutta during the five years, 1876 to 1880, 14 deaths from accidental poisoning occurred, or an average of 6.5 per million of the population per annum; and during the five years, 1889 to 1893, 11 accidental deaths from poisoning are recorded in the same area or 3.6 per million per annum. Certain types of cases of accidental poisoning are apparently almost unavoidable. Those cases, however, which arise from careless dispensing, or from the vending of drugs by ignorant, irresponsible persons, cannot be too strongly condemned. The Bengal Municipal Act, Section 252, and the Calcutta Municipal Consolidation Act, Section 368, were framed with a view to prevent such accidents. They enact that the drugs contained in the British Pharmacopœia, if dispensed on prescription, or when used by any other than a practitioner of indigenous medicine, must be prepared by a properly-qualified compounder, and sold only in registered shops. That a considerable number of these same drugs, when used by a practitioner of indigenous medicine, if not dispensed on prescription, need not be prepared by a properly qualified compounder, and may be sold in a non-registered shop, and further that no restriction or safeguard of any kind shall be placed on the sale of indigenous remedies whether contained in the British Pharmacopœia or not, provided they are not sold in a shop

where British Pharmacopœia drugs are dispensed. This matter will be referred to again when dealing with the proposed restrictive measures.

The difficulty of obtaining any adequate conception of the prevalence of fatal poisoning in the province of Bengal has, no doubt, been already realized. It is in fact only possible to speak with a certain show of authority regarding one town in the whole province, except as regards *murder by poison.*

Of the non-fatal cases of human poisoning, it is only the criminal cases that are recorded. These, for the most part, consist in the administration of stupefying drugs, generally datura, for purposes of theft. It is a class of crime fortunately very rare in European countries. The Bengal Police Returns record 161 such cases during the five years, 1889 to 1893, or an average of .46 per million of the population. As regards other cases of non-fatal poisoning, whether suicidal or accidental, absolutely no general information whatever is to be obtained. It is possible and even probable that their number is very considerable. Thus, at the Medical College Hospital, 103 non-fatal cases of poisoning were treated during the year 1893, but in six only of these cases were the vomited matters or substances suspected to be, or to contain poison sent to the Chemical Examiner for analysis. At the Mayo Hospital, 24 non-fatal cases of poisoning were treated during the year 1893, but in no instance was the matter referred to

the Chemical Examiner by the police *. The Bengal Administration Report shows that at the hospitals throughout the province, about 395 cases of poisoning are treated annually, of which 345 recover, taking the average of the four years, 1889 to 1892. The hospital records thus show a yearly average of 345 cases of non-fatal poisoning.

* We are indebted to Dr. Kedarnath Das, Registrar, Medical College Hospital, and to Dr. Manmathanath Chatterjee, Resident Physician, Mayo Native Hospital, for the two tables in the next page upon which the above statement regarding the non-fatal cases of poisoning has been based.

TABLE I.

Number of poisoning cases treated in the Medical College Hospital during 1893.

Poisons.	Total admission.	Male.	Female.	Child.	Recovery.
Opium ..	66	45	18	3	45
Morphia ..	3	1	1	1	3
Arsenic ..	17	8	3	6	15
Belladonna ..	5	3	2	..	5
Atropia ..	2	1	..	1	2
Datura ..	6	4	2	..	6
Camabis Indica ..	3	3	..	..	3
Bhang ..	1	1	..	..	1
Carbolic Acid ..	2	2	..	..	2
Turpentine ..	1	..	..	1	1
Kerosene oil ..	7	..	..	7	7
Strychnine ..	1	1	..	..	1
Castor oil seed ..	1	..	..	1	1
Camphor ..	1	..	1	..	1
Aconite ..	1	..	1	..	1
Unclassified ..	9	..	..	..	9
Total ..	126	69	28	20	103

TABLE II.

Number of poisoning cases treated in the Mayo Hospital during 1893.

Poisons.	Total admission.	Recovery.
Opium	28	15
Kerosene oil	3	3
Sulphuric Acid ..	1	..
Carbolic Acid ..	1	1
Camphor	1	1
Bhang	2	2
Turpentine	1	1
Aconite	1	1
Carbonic oxide gas ..	1	1
Total ..	39	25

Such is then the account that we are able to supply of the prevalence of human poisoning in Bengal, both fatal and non-fatal. It is manifest that the statistics are lamentably incomplete. More accurate returns are essential. It is hardly possible to suppose that legislation dealing with the free sale of some of the poisons at present in use can much longer be postponed. The measure of the usefulness of such legislation can only be gauged by reference to the statistics of poisoning, both before its introduction and after. It would be opportune, therefore, to now prepare the ground for the introduction of such a measure, by establishing some more accurate system for the record of cases of poisoning.

We would recommend that every case of poisoning, whether fatal or non-fatal, should be reported to the police, and further that in every case, such articles bearing on the case as may be available for examination, be referred to the Chemical Examiner for analysis. This is of course done to a limited extent in Calcutta, but it is questionable, we think, whether, in other large towns of the province, the proposed measures are adequately carried out. At least there are no records to show the results of the action taken.

The annual reports of the Commissioner of Police, Calcutta, and of the Health Officer, Calcutta, already supply more information regarding the nature and frequency of poisoning for the area

dealt with by them than any other similar return. We would suggest, however, that their usefulness would still further be increased by a slight addition to the tabular statements which include cases of poisoning. An extra column might be added to the tabular statement to convey information as to the evidence upon which the deaths were returned as due to poisoning, whether upon medical evidence only, chemical analysis only, or both. Such information is no doubt already available, and would certainly increase the value of these tabular statements. The record of accidental deaths in the police returns, both for Calcutta and the province, contains no return of the number due to poisoning. At present non-fatal cases of poisoning are not dealt with in either of the two reports, but were these cases all reported both to the police and the Chemical Examiner, the results of investigation could be embodied in an additional table. We are well aware that the information contained in a small tabular statement comprising a few lines often requ res a considerable quantity of machinery for its accurate collection. That the larger towns in Bengal should make returns of poisoning cases among their population similar to those furnished by Ca cutta, does not seem, however, to be an excessive demand. They probably are supplied with some of the requisite machinery already. The Sanitary Commissioner's report for the province records the total suicides for

the year, but the number due to poison is not separately furnished. It would be a great advantage if the numbers due to violence and due to poisons could be given separately, and if the nature of the evidence upon which a suicide is declared due to poison could also be added in an abbreviated form suitable for insertion in a tabular statement. A similar remark applies to the Police Administration Report. No information is contained as to the evidence upon which cases are declared to be *murder by poison, drugging, etc.* If this could be added in a form not too bulky for insertion in Statement A, Part I, the analysis of cases of poisoning would be greatly assisted. In the same report, a number of cases are returned as attempts at and abetment of suicide, but whether the attempts were made by means of violence or poison is not shown.

Hitherto we have dealt with the prevalance of human poisoning, but we referred to the fact that the free access of poison produced a class of crime almost special to the rural districts. The crime is the poisoning of animals. It is rare in Europe, but very prevalent in India For the most part, the animals are cattle, and no record of the prevalence of poisoning in Bengal under the conditions now existing would be complete, which neglected this class of crime. During the ten years ending in 1893, 1,413 heads of cattle were suspected to have died from poisoning in Bengal alone. Poison was detected in 75 per cent.

of the cases. Cattle-poisoning is specially to be deprecated as the cattle form in many instances the sole wealth of their owners. It is hoped that the introduction of legislative measures will result eventually in the abolition of this crime. This then concludes such information as we are able to submit regarding the prevalence of all kinds of poisoning at the present time. The way has been thus prepared for the consideration of the nature of the poisoning cases which occur. Before, however, passing to this part of the subject, it will not be out of place to give a brief summary of the history of poisoning in India.

The *Shastras* here and there record cases of poisoning of kings by their nearest of kin in order to obtain possession of the throne and of husbands by their wives for reasons not very apparent. The Mahavarata records the case of Bhim Sen, the second of the Pandavas, who was poisoned by his jealous cousin and rival Durjodhan. Although one cannot vouch for the authenticity of such cases, still they tend to show that poisoning was practised by even the bold Aryan settlers of Northern India.

Sushruta, one of the oldest authorities on Hindu medicine. mentions the practice of poisoning the water-sources of an invaded country with a view to destroy the unsuspecting invaders who might use the poisoned water. This practice is still extant; we hear of the poisoning of the water-sources by *aconite* in Burma and

Nepal at the time of the invasion of those countries by the Brtiish Army. The poisoning of water, is also resorted to for the purpose of destroying fish, and thereby inflicting loss on the owner. Dr. Watt mentions the use of the following plants for the purpose :—
(1) Strychnos Nux Vomica, (2) Lasiosiphon Speciosus, (3) Balanites Roxburghii, (4) Tephrosia Suberosa, (5) Euphorbia Tirucalli, (6) Hydrocarpus Wrightiana, (7) Hydrocarpus Venenata. Besides these, Cocculus Indicus is also largely used for this purpose.

Sushruta also mentions the use of poisons together with harmless substances as charms and love-potions. He described the various modes of administration of poison prevailing at the time, and although the practicability of some of these is questionable, it will not be uninteresting to enumerate them here. Thus poisons were mixed with food, drinks, tooth-powder, anointing oils, honey, fragrant substances used for cleansing the body, medicine, bathing water, essences, snuff, articles used for smoking such as tobacco, black paint and other eye-salves. It is related also that poisonous substances were sometimes sprinkled over garlands, clothes, beds, armour, ornaments, shoes, foot-stools and seats on horses and elephants.

About two centuries before the Christian era, the whole dynasty of the King of Magadha is reported to have been poisoned by a designing minister. Coming to the Mahommedan age,

when intrigues were common both in the court and inside the harem, rivalry in love and political power contributed largely to the increase of cases of poisoning. The victims were either killed or deprived of intellect by the use of poisons less lethal in character. It does not appear to be true, as stated by some earlier European travellers and quoted by Chevers, that the burning of Hindu widows on the funeral pyre of their husbands originated in the fact that Hindu girls used to poison their husbands on the smallest pretext, and that this rite was enforced to put a stop to the practice. During the earlier period of the English Administration, theft by administering intoxicating drugs became frequent and the practice prevails to this day, though to a much less extent. The historical records give but little information as to the poisons in use in ancient times, but show that the poisoner's tradition in India dates back to a very early age. Sufficient has accordingly been now advanced to demonstrate, not only the present prevalence but also the antiquity of poisoning in India. The statistics quoted are evidence that poisoning is unduly prevalent at the present time, murder by poison being thrice as prevalent, and suicide by poison apparently many times more prevalent than in England, where the sale of poisons is under legal restrictions. The conclusion is fairly logical that those measures which have succeeded in bringing about a reduction of poisoning

in other countries may, *cæteris paribus*, be equally successful in India. The fact that the conditions are not the same in the two countries has already been referred to. But it will be seen when the nature of the poisoning in Bengal is reviewed, that the special natural conditions existing in India do not at the present time exercise much influence on the nature of the poisoning which takes place. It is, in fact, of the very kind to be successfully controlled by measures wisely conceived and prudently initiated. A plea much stronger than the statistics of their prevalence is to be found in the nature of the greater number of cases of poisoning which annually take place in the province.

B. *Nature of Poisoning.*—It will be observed as the description of the nature of these cases proceeds, that the users of poisons are very conservative in their application. Each poison has, as it were, its own role or specific use, and is comparatively but seldom employed for other purposes. Thus arsenic is the poison usually selected for murder and cattle destruction, opium is the poison with which to effect suicide, *datura* the drug with which to produce stupefaction, and thus facilitate theft, and so on. The poison selected is generally that which, by long-established precedent, has become the recognized means for effecting the desired purpose. The import or production of some of these poisons is already under the control of the authorities; in the case of some of the others, however, which grow wild

or nearly so, any effectual control will be difficult. From what has already been said, an account of the nature of poisoning cases resolves itself into a description of the classes of poisoning which occur, with the poisons which are generally used in each class. The cases can conveniently be arranged into the following seven classes:—

I.—Murder by poison.

II.—Administration of stupefying drugs in order to facilitate theft.

III.—Administration of poison to effect destruction of the intellect.

IV.—Administration of poison to effect abortion.

V.—Suicide by poison.

VI.—Accidental poisoning.

VII.—Cattle poisoning.

Each class will be dealt with in turn, with special reference to the poison most frequently used in each class. A few fairly illustrative cases will also be cited by way of demonstrating the methods of administration.

I. *Murder by poison.*—Crime of this kind is rare in England; and the facilities for detection and difficulties of concealment are such that the statistics may be regarded as highly reliable. It is hardly possible to assume the same confidence with regard to the available returns in Bengal, for not only are the facilities for detection less, but the possibilities of concealment much greater. In

India, the symptoms of natural disease and the effects produced by poison simulate each other to an extent quite unknown in England, occasionally baffling even experienced medical men. The fact that notwithstanding difficulties of detection, *murder by poison* is three times more prevalent in Bengal than in England, sufficiently indicates an unsatisfactory state of affairs. The circumstances attending specific instances of poisoning illustrate this more fully. In England, it is almost impossible for an individual during a sudden fit of passion to be able to obtain and administer poison to those with whose conduct he or she is incensed. For unless the circumstances were special, such an individual could only procure sufficient poison for his or her purpose after the lapse of a period of time sufficient probably for reason to have regained control of anger. Such cases, however, do occur in India. We can adduce instances the occurrence of which can only be attributed to the ease and rapidity with which the poison was procured. Thus in 1893, the youngest brother in a high caste Brahmin family, residing in the vicinity of Calcutta, having had some misunderstanding with two of his elder brothers, quietly entered the kitchen and mixed powdered white arsenic with some common salt lying there for immediate use. A curry was prepared with the poisoned salt and eaten by several members of the family, all of whom developed symptoms of irritant poisoning. Fortunately,

the quantity of salt used was small, and but little of the curry was partaken at the particular meal. The victims all recovered. The common salt, the curry, and the vomit of some of the affected persons were sent for examination. Arsenic was detected in all of them. The culprit is still at large. Such cases can be multiplied, but the examp'e given is a typical one of its kind. Typical, too, in many ways, in the absence of premeditation, the method of administration, and the selection of the poison. The two poisons most readily attainable are probably opium and arsenic. The former is not suited to the murderer's purpose, for its appearance and taste might lead to its early discovery. White arsenic, on the other hand, is tasteless, and powdered and mixed with common salt, would readily escape detection.

Classified according to the motive, cases of murder by poison in India can easily be arranged into types equally familiar in all countries. Thus in India, as in other countries, revenge, jealousy, lust, greed and avarice may, any one of them, instigate the act. The motives are the same everywhere.

We have referred to those acts of poison administration which resemble acts of homicidal violence during the heat of passion, and which probably are often followed by as speedy a repentance. But besides cases of this kind, a very large number occur annually where the poison has been administered after

long premeditation and with deliberate intent. Our paper is intended to demonstrate the need for legislative interference with the free sale of poisons in India and for the enactment of laws regarding the possession of poisons by individuals in this country similar to those in England. If such measures are to be successfully introduced, cognizance must be taken of all the circumstances special to India. It would naturally be supposed that cases of deliberate poisoning, premediated during a considerable period of time, are those which can be dealt with least effectively and with the greatest difficiulty. The poisoner has time, and may be opportunity, to select a poison the detection of which is difficult. Does he do so? Experience shows that he seldom attempts any thing of the kind, but utilizes the one well-known poison, *viz.*, arsenic. Scientific poisoning is practically unknown in India. As a rule, large quantities of poison are administered, and whether the act be sudden or long premeditated, the one poison commonly chosen to effect murder is the easily detected poison, *arsenic*. We will cite a case of long premeditated and determined murder by poison which occurred in 1893 to illustrate the point. A Sikh, named Rajah Singh, the prospective heir to some property, had a long-standing dispute with some of his co-religionists regarding the estate. Taken one day by one of these men, Jowhir Singh, to the Sikh temple in Burrabazar, he was given *Karaprasad*, a sweetmeat sacred

among the Sikhs, to eat. While eating it, Rajah Singh objected to the taste, and protesting that it was not the real *Karaprasad* but the ordinary sweetmeat or *halua*, wanted to eject it from his mouth. He was, however, persuaded to swallow the sweetmeat on the ground that, as a true Sikh, he ought not to insult the *Karaprasad*. Shortly after, he left the temple to return to his house. He became very ill on the road and vomited once. On arriving at his house, he became very ill, suffering from vomiting and purging. Suspecting that he had been poisoned, he communicated his suspicions to his mother and other relatives. He was then taken to the Medical College Hospital, where his stomach was washed out, and where he made the above statement to the medical officer on duty. Next day he died. The stomach washings and viscera were sent to the Chemical Examiner for analysis and arsenic detected in both of them. Here avarice was the motive. Very frequently, the motive is lust. Thus, during 1881, a case was referred from Cooch Behar, in which a faithless wife poisoned her husband with arsenic, and afterwards married her paramour. Arsenic has occasionally been used by step-mothers to remove unsatisfactory step-sons. In May 1884, Charcoo Nasya, a Mahomedan lad, aged 19 years, died at Dinajpore with symptoms of vomting and purging, after partaking of food given him by his stepmother. Arsenic was detected in the vomited

matter and also in the viscera.

In cases of murder by poison, white arsenic is chiefly used, yellow arsenic occasionally and red arsenic rarely. *Darmuj* and other arsenical preparations are very rarely employed.

As will be shown later on, the greater quantity of arsenic in the country has been imported by sea. The quantity naturally available in India is very small; yet to-day the drug is to be found everywhere. How then has its dissemination and the knowledge of its properties become so general? The question is interesting, and not entirely speculative; for it might be possible from such data to ascertain the period of its rise into favour as a poison. We have stated that arsenic is the poison most frequently used to effect murder. A definite statement, giving the percentage of cases of murder by poison in which arsenic has been the poison selected, ought to be forthcoming. Unfortunately, no such statement is available. The Chemical Examiner's reports show in what proportion of fatal cases of poisoning of all kinds arsenic has been detected, but the cases cannot be classified with any certainty by the Chemical Examiner from the information supplied to him.

Next in frequency of use to arsenic comes *aconite*. The following is a typical case of aconite poisoning:—On 6th May, 1891, three coolies of the *Chamar* caste, were found lying dead in the Dhurrumtolah market; two others

were unconscious, but subsequently recovered. The investigation showed that all five men had been poisoned with aconite mixed in their food by one Jeetoo Chamar at the instigation of Sunnoo Chamar. All concerned were fellow-countrymen, and had been friends up to the time of the act, the cause for which apparently consisted in the fact that one of the murdered men had a quarrel with Jeetoo Chamar, who thereupon introduced poison into the common meal of five individuals, with four of whom he was not in any way at variance. No example could be more striking of the recklessness of the poisoner on the one hand, or, on the other, of the small provocation required in some instances to induce the act.

Besides *arsenic* and *aconite*, preparations of *mercury*, *copper*, *antimony* and *nux-vomica* are occasionally, though rarely, used for the purpose of murder. The smell and other physical characters of opium are effectual obstacles to its frequent employment for murder. It is used, however, to effect infanticide, and sometimes is given in wine to drunken individuals to effect murder. On one or two ocacsions of late years, the alkaloids—*strychnine* and *morphine*—have been employed. The method of administration is that in use from time immerorial, *viz.*, of mixing the poison with the food. Thus yellow arsenic can be fairly well concealed in *dal*, curry, and white arsenic in common salt. All articles of food are utilized. If the poison be tasteless,

or nearly so, and well concealed in the food, the better is it taken by the victim.

II. *Poisons to stupefy.*—This class of crime is but little known in Europe. In India, it is very frequent. The police returns for the province of Bengal show that twenty-three cases of administration of stupefying drugs to cause hurt occurred in 1893. The drug almost universally employed is *datura*, well-known as the *Thug* poison, since those of the *Thug* gangs, who were not adepts in the use of the sling, employed *datura* to drug their victims, and subsequently robbed them when helpless. The history of one instance of *datura* poisoning is practically the history of all of them. A stranger joins a party of individuals on a journey, and wins their confidence sufficiently to be allowed to cook or prepare their food, into which he introduces powdered *datura* seeds. On one plea or another, he excuses himself from partaking of the common meal which is eaten by the remainder of the party, who succumb to the influence of the drug and are easily robbed. Robbery by means of *datura* is almost a profession, and many of those who practise it display considerable dexterity in the method by means of which the admixture of the poison with the food of their victims is carried out. The use of a hollow pestle filled with powdered *datura* seeds, and having a small orifice at the lower end, is sometimes resorted to. The pestle is employed to grind the pepper and other condiments for

use in cooking the food, and the drug is thus successfully introduced therein without even exciting the suspicion of the victims. The employment of *datura* is probably encouraged by the popular belief that it produces unconsciousness only and not a fatal result. The use is for the purpose of making robbery easy and of avoiding violence. Murder is not the object, but the reverse. The administration frequently, however, results in murder, as the following record will show. In July, 1894, at Monghyr, *datura* was administered to the crew of a boat numbering eight persons, one of whom subsequently died from the effects of the drug. The robbers got off with their booty. As the case is typical, the following account furnished by Surgeon-Major D. G. Crawford may prove interesting:- "Two men took a boat at Sonpur to carry them to Narayanganj. On the evening of the 22nd July, the boat was tied up for the night at Gogri opposite Monghyr. The crew, consisting of seven men and a boy (son of deceased), took their food as usual about 9 or 10 p.m. They went to sleep. Next morning, they were all found insensible, and one died about noon. The other seven were sent to Monghyr where they arrived at about 2 p.m. on 24th July. I saw them at about 4 p.m. All had somewhat dilated pupils. One talked somewhat incoherently, the rest appeared to have fully recovered. All their property had disappeared; so had the two

passengers who are supposed to have mixed drugs in their food for purpose of robbery. The two passengers being of a different caste did not eat with the crew." In most cases of *datura* poisoning, the whole fruit or powdered seed is administered mixed with solid food. In such cases, fragments of the seed can frequently be detected on microscopic examination in the vomited matters, the excrement, and in the food. Occasionally, though not frequently, spirituous liquors are made the vehicle for the administration of the drug. During the current year, a case occurred in which *datura* was administered in this manner. A prostitute was visited by a man who, in the course of the interview, offered the woman some country liquor to drink and in proof of its character drank some himself. After drinking the liquor, the woman became unconscious, and the man with whom she had had no previous acquaintance, having stripped her of her ornaments, tried to decamp. In this case, *daturine* was extracted from the country liquor, from the stomach washings, and from the excrement of the poisoned woman, as well as from the stomach washings of the accused. As already stated, the employment of *datura* is almost invariably for the purpose of facilitating theft. One instance, however, occurred during the current year (1894), where it was administered to facilitate the murder by violence of a Hindu male, sixty-five years of age. This man had two wives, of whom the younger,

Matangini, had contracted an intimacy with another man. The husband objected to his wife's misconduct, in which, however, she persisted, notwithstanding an occasional beating at the hands of her husband. On May 30th, instigated by the woman who arranged the interviews with the paramour, Matangini mixed a whole *datura* fruit in the curry which formed her husband's meal. When the husband had become unconscious, Matangini killed him with a *dao*. On the discovery of the dead body, the murderess made a full confession of her crime.

III. *Poisons to destroy intellect.*—Such cases of the crime as might come to the notice of the authorities would, no doubt, be included under the heading of the administration of stupefying drugs to cause hurt. The drug employed is almost always *datura*. But little is known regarding the crime, and the production of specific instances is impossible. It is carried out secretly and very gradually so as to simulate the natural course of mental disease and to excite the suspicion neither of the victim nor his friends. It is stated that women administer *datura* to their husbands in this manner, in order to obtain opportunity for the successful prosecution of love intrigues; and that prospective heirs to large properties are thus deprived of reason by individuals interested in the succession, as under Hindu law, insanity is a bar to inheritance.

IV. *Poisons to effect abortion.*—The average annual number of cases of *abortion* reported in the Bengal Police Administration returns for the years 1888 to 1892 was 24. It is not stated whether these are cases of simple abortion or death, the result of the attempt. In none of these years either was any case reported as having occurred in the town of Calcutta. The small number of the cases reported for the whole of the province, and the fact that none are reported from the town of Calcutta, may be taken as almost sufficient evidence that a small number only of the cases that actually occur ever come to light. A practice in procuring abortion is carried on by certain women of low caste, who occasionally administer sufficient poison to their clients to effect a double murder. These women frequently pass themselves off as midwives. The method generally employed is the introduction into the cervix uteri of the stems or roots of plants which possess irritant active principles. Thus plumbago rosea (*lalchitra*), nerium odorum (*karabi*), calotropis gigantea (*akand*), euphorbia tirucalli (*lankasij*) and others are utilized. Sometimes bamboo sticks, coated with assafœtida, are introduced to effect the purpose. The violence used together with the local action of the drug occasionally sets up hæmorrhage or septicæmia ending in a fatal issue and the discovery of the crime. Now and then, drugs are internally administered in the attempt to procure abortion,

and have been found after death in the viscera of women who have died as the result of the attempt. Arsenic, yellow oleander, colocynth, plumbagin (the active principle of *lalchitra*), and other poisons have been detected in the viscera in such cases.

V. *Suicide by poison.*—The degree to which suicide prevails throughout the province of Bengal has already been dealt with. It has been pointed out that there is every reason to believe that suicide is on the increase, at any rate in Calcutta and other large towns. Part of this apparent increase may be due to the better system of records now in vogue in Calcutta; but it can hardly account for the total increase which the figures indicate. Thus the total suicides from all causes in Calcutta town and suburbs, which were 84.94 per million per annum for the five years, 1876 to 1880, had swollen to 123.52 per million per annum during the five years, 1889 to 1893, showing an increase of 38.58 per million. This fact is serious, and becomes more so when it is understood that, of the total increase of 38.58 per million, suicide by poison accounted for 32.42 per million. Of the total suicides occurring annually in the town and suburbs of Calcutta, 40 per cent. are accomplished by taking opium, arsenic is selected in 5 per cent. of the cases, and other poisons not indicated in 11 per cent.

Among the population dwelling in the municipal area of Calcutta during the year, 1st June 1893 to 1st June 1894, 52 deaths by poison occurred; of these, 44 (all suicidal) were due to opium or 84.6 per cent.* The facts then that claim attention are the following, *viz.*:—(*a*) That the crime of self-destruction has enormously increased during the last ten years, and that the cases which have produced the increase are almost entirely those of suicide by poison; for while during the five years, 1876 to 1880, the average of suicide by poison to the population was 36.42 per million, in the period, 1889 to 1893, it had risen to 68.84 per million, or nearly double.† (*b*) Of one hundred cases of suicide occurring in the town and suburbs of Calcutta, 56 are due to poison; and of the 56, in 40 opium has been the poison taken, in 5 arsenic, and in 11, other poisons. It is well recognized by the writers of this paper that the conditions of life

* Dr. J. B. Gibbons informs us that of the 52 cases of poisoning in which he made a *post-mortem* examination, 44 were due to opium, 1 to sulphuric acid, 5 to arsenic and 2 to hydrocyanic acid.

†Suicides from all causes in the town and suburbs of Calcutta:—

During the period,	1876—1880	.. 84.9	per million	per annum.
Ditto	1889—1893	.. 123.52	"	"
Increase		38.58	"	"

Suicide by means of poison throughout the same area —

During the period,	1876—1880	.. 36.42	per million	per annum.
Ditto	1889—1893	.. 68.84	"	"
Increase		32.42	"	"

existing in the town of Calcutta find no counterpart in the rural districts of the province, and only to a limited extent in the large towns at the present time. Still as increase in the crime may be regarded as the outcome of unhealthy social conditions, and as the social conditions existing in Calcutta must sooner or later prevail in all the towns of the province, and at some remote period in the rural districts also, it would be interesting to enquire what those social conditions are in which an explanation of the increase in the crime of suicide must be sought.

Except in a certain proportion of those cases where suicide is resorted to in order to escape the extreme penalty of the law, it is justifiable to regard all cases of self-destruction as the result of a temporarily or permanently unsound mental state. A healthy mind in a healthy body is probably the greatest of earthly blessings. Their varying conditions mutually interact, however, to the impairment or otherwise of their individual functions. Thus the physical conditions of the dwellers in large towns are often such as to interfere with healthy mental action and development. A diseased or unsound state of mind may be permanent or temporary, may arise from the exaggerated development of certain mental attributes, or from a deficiency in the development of others. It may be organic lesion or functional derangement only, and may proceed from over-strain,

from vicious habits of life, or from over-indulgence, as the addiction to the excessive use of alcohol or Indian hemp and other drugs. In a large population, there is always a certain proportion of mentally weak individuals, in whom the condition either exists as a congenial defect, or has become developed as the temporary or permanent result of circumstances. In the case of such individuals, self-control is weak or deficient, and imagination not habitually kept in check by the higher mental faculties. When a community is affected by any social wave or change, these are the members of the community, who, as a rule, display the most evident symptoms of the movement, acting as it were the part of social weathercocks. They are the most ready to adopt new phases of thought, and to sever themselves from their ancient religion and traditions. The religious system of a country is for the most part calculated to support its social fabric, to assist the individual in maintaining moral and mental self-control, not only in times of prosperity, but also in times of adversity. It may be noted in the histories of nations that, when the influence of the national religion is weakened from any cause, a measure of social convulsion often ensues. The extent and nature of the social movement must depend upon the natural mental calibre of the country, if outside influence be excluded. At the present time, in Calcutta and other large towns of India, a social movement of the kind referred to is

taking place chiefly among the younger members of the community, who seem to be emancipating themselves from the tradition and influence of their ancient religion. Those among them less mentally robust than the majority are thus deprived, not only of that support which religious belief affords to weak wills, but also of the influence which the doctrines of their religion exert. Thus, as regards suicide, the *Shastras* inculcate that there is no salvation for the individual who has destroyed his own life. In former times, the Hindu placed implicit faith in the *Shastras*, but his descendants are in many instances falling away from the belief. The modern Hindu is more an artificial than a natural product. Furnished even in his own country with a foreign education and living within touch of a foreign system of civilization, he has, in many cases, lost the patience and resignation engendered by his ancient creed to gain instead imaginary wants and wild aspirations improbable of realization. Such influences acting upon any minds not absolutely sound are prone to produce outbursts of one kind or another on small provocation. A hypersensitive condition is induced and events quite insufficient by themselves upset a feeble mental balance and give rise to such an exaggerated estimate of even trifling troubles that self-destruction is resorted to.

The exicitng causes which, acting on an unhealthy mind, induce suicide are the same in

every country. Ill-treatment, quarrels, jealousy, despair, destitution and physical suffering, all can claim their victims and among both sexes. But in Bengal, as in England, the incidence of suicide is unequal in the two sexes. In England, the male sex furnishes the larger number of cases; in Bengal the female, according to the Sanitary Commissioner's reports. It has been shown that suicide has increased of late to a painful extent among the Hindu population of Calcutta. The cases that occur are of all kinds. Thus merchants on pecuniary reverse, students failing to pass their examinations, disappointed suitors, wayward sons checked by their parents, and unhappy girl-wives, all attempt to find in suicide an escape from their real or supposed misfortunes. The minds of the young, possibly the women chiefly, do not acquire a healthy tone from the perusal of the sensational worthless novels now being published in large numbers by the vernacular press of Bengal. We presume that every one now-a-days admits that persons who attempt or commit suicide should in most instances be regarded as either permanently or temporarily irresponsible for their actions. They are, therefore, legitimate objects of care to the legislator according to the modern conception of civilization; and since the easy accessibility of poison is responsible for a large number of suicides, it is this very easy accessibility of poison which should first be dealt with by legislative interference. Opium

has been shown to be responsible for the majority of cases of suicide in the municipal area of Calcutta, whether by violence or otherwise; and opium is to be found in any quantity everywhere throughout the country. Other poisons are also used, and among them some, the introduction of which into the country is only of recent date, and due to the development of certain trades, such as photography and electro-gilding. By this means, *cyanide* of *potassium* has become known and has been employed in one or two cases. The extensive development in the trade of European drugs has familiarized many among the educated classes with their qualities and led to their employment also to effect suicide. As already stated, no figures are available to show what proportion of the suicides reported in the Sanitary Commissioner's Return is due to poisoning, or what was the nature of the poisons chiefly selected. It is accordingly very difficult to obtain any idea, not only as to the number, but also as to the nature of cases of suicide by poison occurring in the province outside Calcutta. The Chemical Examiner's report may, however, be accepted as representing the nature of human poisoning generally which prevails in the province, although it does not profess to be a complete numerical return. If besides this our statement be accepted that, according to the account given by the forwarding officers, the cases in which opium had been detected were, for the most part, cases of suicide,

then the figures given in the Chemical Examiner's report may serve to demonstrate the nature of the poison selected in cases of suicide by poison throughout the province generally. The results of poison detection in human viscera, forwarded to the Chemical Examiner during the past ten years, are given in the table given in the next page :—

TABLE III.

Shewing the percentage of poisons detected in human viscera during ten years ending 1893.

Poisons.	1884	1885	1886	1887	1888	1889	1890	1891	1892	1893
Opium (including Morphia) ..	63.73	57.96	48.23	60.6	59.7	63.35	46.73	53.52	62.65	61.37
Arsenic	26.43	31.84	42.46	34.64	28.96	31.2	33.15	25.74	24.53	24.8
Aconite	4.81	3.72	.87	.95	Nil.	Nil.	4.32	8.07	4.6	5.87
Indigenous vegetable poisons, such as Nux Vomica, Datura, &c.	2.40	3.73	4.38	.95	2.01	1.96	3.27	8.07	3.32	3.72
Other poisons, such as Hydrocyanic Acid, Alcohol, Mercury, &c.	2.58	2.75	4.06	2.86	9.23	3.49	12.53	4.6	4.9	4.24

The information afforded by the table may be returned in round numbers as follows, that, taking the results of ten years as the basis for the calculation, opium and arsenic constitute 90 per cent. of the poisons detected. Opium by itself is the poison detected in 58 per cent. Then bearing in mind the statement already made regarding these cases of opium poisoning, this figure, *viz.*, 58 *per cent.*, may be regarded as indicating the conditions influencing poison selection in cases of suicide by poison throughout the province.

VI. *Accidental poisoning*—The most cursory consideration of any record of cases of accidental poisoning must always produce the conviction that the term is almost a misnomer. It is rare to find an instance of accidental poisoning unassociated, either with culpable ignorance or grave neglect. There is an old adage regarding the care of edged tools, and surely such poisons as opium, aconite, nux vomica and arsenic are as dangerous as many edged weapons. Yet, if we are to be guided by our knowledge of actual cases, we must believe that to-day, in some humble households in Calcutta, a poisonous dose of opium is within the reach of children barely able to walk,—a want of parental forethought which is productive of cases of opium poisoning. The shops of the *bunniahs* constitute another danger, for they are the source whence all classes of the community, both European and Indian,

either directly or indirectly through their servants draw their supplies of spices and condiments. The *bunniah*, besides selling spices and condiments, is a retail vendor of sago, barley, sugarcandy and indigenous medicines, both mineral and vegetable, together with a few European drugs. The *badia*, with whom the general community are less concerned, sells fresh vegetable drugs only. Both *bunniahs* and *badias* are, as a rule, ignorant people, scarcely able to read or write their own language. Their knowledge of the properties or identity of the drugs they sell is very imperfect, and the manner in which the drugs are stored renders their ignorance almost criminal. In a *bunniah's* shop, even the poisonous drugs are generally kept in unlabelled earthern "*handies*," which may happen to be in close proximity to harmless drugs, spices and condiments. From memory and practice, the *bunniah* is usually able to sell his wares without mistake, but should the position of the pots be changed without his knowledge, most serious accidents may arise. On one occasion, a customer was supplied with strong nitric acid in place of spirit of wine, and on another, nux vomica bark (*kuchila*) was supplied instead of Wrightia antidysenterica (*kurchi*). The latter mistake caused the death of a child. Mistakes are occasionally made even by competent persons well acquainted with the nature of the drugs they vend. A mixture of santonin and strychnia

was, once, supplied at a chemist's shop to a customer in place of santonin, and on another occasion, the proprietor of a Medical Hall, addicted to the use of opium, administered to himself, by misadventure or carelessness or both, a dose of extract of nux vomica, instead of his usual morning dose of opium. In both these instances, the mistake was followed by a fatal result. Somewhat similar to the sale of drugs by ignorant *bunniahs* and *badias*, and quite as dangerous is the trade in secret preparations and quack remedies. This class of medicines finds a large and ready market among the poor and ignorant classes of the country, the sale no doubt being assisted by an eloquent, if untruthful, description of their origin and virtues. Instances are recorded of credulous peasants having been induced to believe that medicines bought by them from some of these unscrupulous vendors were obtained as a special favour from the gods. The medicines often contain poisons, and as they are prepared by ignorant persons, the dose is often, if not always, excessive. Many instances of poisoning produced by taking quack remedies are on record. Thus, in 1880, at Sibsagar, a woman took one of a number of pills sent to her from Calcutta with the recommendation that they were warranted to cure dysmenorrhœa, amenorrhœa, leucorrhœa, menorrhagia and uterine troubles generally. Within half an hour of taking the pill, well marked symptoms of strychnia poisoning were

induced. The pills were found to contain strychnia. In 1882, a sepoy of a native infantry regiment was found to be in possession of some medicinal preparations by means of which to his own pecuniary benefit he had been in the habit of supplementing the regular medical treatment of his sick comrades. Some of the men thus treated developed symptoms of irritant poisoning, while others displayed symptoms of mercurial marasmus. On analysis, the preparations were found to contain arsenic, antimony, and mercury. During the current year, six samples of a stock of medicines which were in considerable request among the poor of Calcutta as cancer cures, etc., were referred to the Chemical Examiner for analysis. Four of them contained arsenic.

Certainly less creditable and possibly more criminal even than the foregoing is the class of so-called accidental poisoning that we now propose to briefly consider. It arises from the use of charms, love philters, and of medicines administered with a view to excite the sexual passions. Charms and love philters are in common use among the ignorant people of the country, and, though for the most part, they are harmless preparations of betel and different kinds of root fibre, yet occasionally they are compounded of poisonous drugs, such as aconite, arsenic and datura. As a consequence, an undesired and unforseen fatality occasionally results from their use. Thus, in 1884, a man

unintentionally poisoned his wife, a young girl only 14 years of age, by giving her a so-called love philter mixed with sugar. The girl disliked her husband, and was in the habit of deserting him. The love philter which contained arsenic was administered by the husband apparently in the honest hope that he might thereby gain his wife's affections. Allied to the administration of charms containing arsenic and other drugs is the habitual use of arsenic by certain classes of people in India on account of its supposed aphrodisiac properties.

Up to this point, we have dealt with accidental poisoning, only in so far as it arises from the use or misuse of poisonous drugs as such; but cases of accidental poisoning also arise from the introduction, for the most part through ignorance, of improper substances into food-stuffs. As an example of this may be cited the colouring of sweet with poisonous pigments by the ignorant sweetmeat-sellers of the country. The pigments disocvered to have been used in this way are yellow arsenic, verdigris, Scheele's green, chromate of lead, magenta, and other aniline dyes. Cases of this kind are well within the reach of police interference, and it must be said are generally prevented in Calcutta. Occasionally also, a poisonous vegetable substance due to some mistake as to its identity is prepared and eaten as food. The following case occurred in 1893 and is an interesting example of the kind. Some individuals near

Dacca made a curry of a tuberous root, which they had obtained from a neighbouring jungle. and mistaken for "*matia aloo*". After partaking of the curry, "they became intoxicated and vomited, remaining insensible for six hours. They then regained their senses." On analysis, the tuber and the curry were found to contain a violent irritant and narcotic poison. Neither the tuber nor its active principle has yet been identified. Cases of this kind are, however, rare and present a marked contrast to the majority of instances of so-called accidental poisoning, most of which are at least culpable, if not criminal.

VII. *Cattle poisoning.* A glance at the following table will show at once the nature of the cattle poisoning which takes place. Its undue prevalence has already been considered :—

TABLE IV.

Shewing the percentage of arsenic detections in animal viscera and in substances sent for examination as cattle-poison during ten years ending 1893.

	1884	1885	1886	1887	1888	1889	1890	1891	1892	1893
Animal viscera	100	100	100	100	100	100	100	100	100	100
Cattle poisons	..	92.59	96.4	92.35	95.78	94.73	93.66	92.36	93.18	92.5

Practically arsenic is the sole poison employed for the destruction of cattle. It has many advantages over other poisons. It is tasteless, certain in its action, and the dose required is small. Further, the hides of animals poisoned with arsenic are more easily preserved. The method of administration is as follows:—A small quantity of white arsenic is made into a paste with flour, oil or oil-cake, and then wrapped up in plantain or other leaves and thrown before cattle grazing in a field, or introduced into the manger among the fodder. The seeds of abrus precatorius, croton seeds, and yellow oleander are also used as cattle-poisons, though but rarely, in Bengal. The seeds of abrus precatorius are made into a paste, which is dried and then fashioned into a miniature arrow-head, about 1 inch long and $\frac{1}{5}$th inch in diameter at the base, constituting in this shape the well-known "*sui* poison." The "*suis*" thus prepared are forcibly introduced through the skin of the animal to be poisoned. In the Punjab, similar "*suis*" are prepared with arsenic in place of abrus precatorius seeds. Though cattle are occasionally poisoned to satisfy a grudge, the more usual object is the possession of the hide. The poisoners are a class of people known as *Chamars*, who, in return for their services in skinning cattle, are allowed to claim a percentage of the profits derived from the sale of the hides. The destruction of dumb animals, which at present prevails in India, is

not only accompanied with much physical suffering on the part of the animal, but it is also unnecsessary. If fresh supplies of poison be cut off, with the gradual exhaustion of the stock of arsenic existing throughout the country, a diminution in this class of crime may confidently be expected. The measures proposed for restricting the supply of arsenic will be dealt with later in detail.

By the consideration of the prevalence and nature of the poisoning in the province of Bengal at the present time, we have shown the necessity for some measures calculated to bring about a reduction of the present prevalence. The measure which naturally commends itself, and which has been successful in other countries, is that usually described as a restricted and regulated sale of poisons. Accordingly, we now pass to the consideration of the best and most feasible means for restricting and regulating the sale of poisons in Bengal.

C. *Measures proposed.*—As recommendations having the same object in view have frequently been made during the past half century, it would be as well to refer to these first, and then deal with the scheme now proposed. Accordingly, our remarks concerning measures proposed for restricting the sale of poisons are easily arranged into the following three sections :—

(1) Previous recommendations and their outcome.

(2) Proposition now under discussion.

(3) Difficulties attending the introduction and working of such a measure, or briefly its *pros* and *cons*.

(1) *Previous recommendations.*—From the year 1843, when Dr. Mouat drew the attention of Government to the matter, up to the present time, the recommendations to control the sale of poisons have been numerous and frequent. Some of these will now be reproduced. Thus, in 1856, Dr. Mouat's contention was supported by Dr. Chevers, who then wrote as follows:—

"It certainly appears to be a matter of great importance that the importation, or at least the sale, of *arsenic* in India should be regulated by stringent legislative enactment. *There is no law in India prohibitory of the sale of poisons.*"

The experience of medical officers in Madras corroborated that of medical officers in Bengal; for in 1879, the Surgeon-General and the Chemical Examiner to the Government of Madras submitted the following statement to their Government. The Chemical Examiner in his report states that—

"Arsenic is far more frequently used than any other poison. Attempts at poisoning with other poisons unless accidental have probably rarely succeeded. There can be little doubt that in this Presidency, the determined poisoner is pretty sure to make use of some arsenical compound. The destruction of human and animal

life by this poison is so considerable that some restriction upon the sale of arsenic is from the medico-legal point of view highly desirable."

When forwarding the Chemical Examiner's report, Surgeon-General W. R. Cornish, F.RC.S., C.I.E., recorded the following views:—

"In passing on this report to Government, I feel that I should be wanting in my duty if I did not bring prominently to the notice of Government that the experience of the Chemical Examiner's Department shows most conclusively that the poisons resorted to by the people of India for criminal purposes are mainly common arsenical preparations or mercurial salts, and that no restriction whatever is placed on the sale of such things in this part of India. I have no doubt that if some wholesome restriction was brought to bear on the trade in arsenical and mercurial preparations, and in some of the more common organic poisons, the crime of administering poison would be less frequent and more easy of detection than it now is, and I venture to hope that the Government may be prepared to deal with the question having for its object the restriction of the sale of poison in the Presidency. It is not creditable to our administration in this particular that, within the last year, no fewer than three persons in the town of Madras should have been enabled to commit suicide by purchasing at druggists' shops, without let or hindrance, quantities of chloral hydrate sufficient to cause death."

The necessity for restricting the indiscriminate and irresponsible sale of poisons, specially arsenic, was frequently dealt with by Dr. Warden, the late Chemical Examiner to the Government of Bengal, in his annual reports. The following remarks appeared in the report for 1882 regarding cattle-poisoning :—

"Arsenic is the posion generally used. Enormous quantities are found in the parcels of suspected cattle poison sent for examination. In one case, one pound of white arsenic was found in two packets. It has been urged that any special legislation to restrict the sale of poison would be useless, because indigenous vegetable poisons are to be found in every hedgerow. This is a fallacious argument. Because vegetable poisons happen to be common, it does not follow that arsenic is to be picked up in roads and ditches. Arsenic is *par excellence* the poison used for criminal purposes in India. If it is impracticable to restrict the sale of all poisons, the indiscriminate vending of arsenic might be diminished by levying on it a prohibitory tax which could place it beyond the reach of the masses. The legitimate uses of arsenic in this country are not numerous, and for the purposes of certain trades, it might be issued duty-free, but under the most stringent restrictions."

Dr. Waddell, while officiating as Chemical Examier in 1884 during the absence of Dr. Warden, referred to the necessity for legislative action, similar to that existing in England, in

the following terms, which were noticed by Government in an interesting resolution, also reproduced :—

"The necessity for the imposition of certain restrictions on sale of poisons has on more than one occasion been represented, and has attracted the attention of the Government. The Lieutenant-Governor in the resolution on the report for 1882-83 said that 'the general question as to the imposition of restriction upon the sale of poisonous drugs demands, and will receive, separate consideration.' But up till this time, no steps have been taken in this direction. The restrictions in force in England work without trouble to the authorities there, and it is reasonable to suppose that in India as in England, increased difficulty of access would soon render the use of poisonous drugs less frequent."

The Government resolution on Dr. Waddell's report is quoted below :—

"The question of the restriction to be imposed on the sale of poisonous drugs has been more than once under the considration of the Government. It is beset with many difficulties. Poisonous substances exist in every hedge and garden throughout the country, and in the present state of society in Bengal, it seems quite impossible that the sale of poisons generally can be effectually controlled. What is more important is to check the ignorant compounding of English drugs and medicines. With this

object, provision has been made in the Bengal Municipal Act, 1884, for the registration of shops for the sale of European drugs and for the employment in them of dispensers duly certified as fit persons to be entrusted with such duties."

In 1886, Dr. Warden thus commented on the above resolution :—

"It is true, as was pointed out in the resolution on the Chemical Examiner's report for 1884, that the subject is beset with many difficulties. But there does not appear to be any valid reason why an attempt should not be made to restrict the sale of some, if not, all poisons. The state of society in Bengal is hardly likely to change materially for a few centuries. A complete bill, similar to the English Poison Schedule of the Pharmacy Act, it is Utopean to anticipate for India. The provision in the Bengal Municipal Act, 1884, for registration of shops for the sale of European drugs is apparently intended to check the ignorant compounding of English drugs and medicines by unqualified druggists and for the registration of shops for the sale of European drugs. But this legislation, though highly desirable, is surely less important than some enactment which would prevent *bunnias* and native drug-vendors from indiscriminately selling arsenic to anybody who can afford to purchase it. The provision of the Bengal Municipal Act protects to some extent the European com-

munity and the higher educated classes of the natives. But the lower classes, most in need of protection, are not benefitted."

In 1887, Dr. Warden again wrote as follows :—

"The increase for the last two years in the number of cases in which arsenic was detected in suspected articles, when taken into consideration with the fact that a similar increase is also apparent for the same periods in the number of cases in which arsenic was detected in human viscera, points, in a most unmistakable manner, to the desirableness of speedy legislation to prevent the indiscriminate sale of poisons. Obviously, no enactment would prevent individuals with a suicidal mania from destroying themselves with poison, if so disposed. Legislation is required to prevent the use of poison for homicidal purposes, and the one poison which is used in India for this purpose is arsenic."

The matter has also attracted the attention of the "British Medical Journal." The following is an extract from an article, published in the October number of 1892, dealing with the free sale of poisons in India :—

"We have from time to time called attention to the great danger to the public and the serious encouragement to the criminal tendencies occasioned by the unrestricted traffic in deadly poisons in India. We are aware of the old argument of those who counsel non-interference, *viz.*, that in a country where deadly

herbs grow on every roadside and open space, it is impossible to prevent their improper use. But the argument scarcely applies to the wholesale and retail dealings in *white arsenic*, which we understand can be bought without let or hindrance, or any record of the sale or purchase, in every village bazar throughout the country. The Chemical Examiners to the various Governments invariably show that in about three-fourths of the cases in which poison is used with criminal intent, the article selected is *white arsenic*, not only for putting away of obnoxious individuals, but for the destruction of the cattle as well."

Such then are some of the recommendations which have been made from time to time during fifty years. What has been the result?

The result so far has been the passing of certain sections of the Bengal Municipal Act of 1884 and of the Calcutta Municipal Consolidation Act. For convenience of reference, these two sections are given in the foot-note below*. They secure, as already stated on page 4, that all shops engaged in the retail trade

* Bengal Municipal Act, Section 252.—"No shop or place shall be kept for the retail sale of drugs recognized by the British Pharmacopœia not being also articles of ordinary domestic-consumption, unless the same shall have been registered in the Office of the Commissioners. Any keeper of such shop or place failing to register the same within two months after the section shall come into force, or within two months from the date of the establishment of such place, shall be liable to a fine not exceeding one hundred rupees. The Commissioners shall, upon registration, grant the keeper of such shop or place a license, which he shall be bound to display in some conspicuous part of his premises.

of British Pharmacopœia drugs should be registered, and that the compounders employed in these registered shops should be properly qualified.

No person shall compound, mix, prepare, dispense or sell any drug in any such registered shop or place, unless he be duly certified as a fit person to be entrusted with such duties under rules made for that purpose by the Local Government :

Provided that the provisions contained in this second clause of the section shall not come into operation until after the expiration of a period of six months from the publication of a notification to that effect in the *Calcutta Gazette* by the Local Government.

Nothing contained in this section shall be construed to apply to the sale of drugs used by practitioners of indigenous medicines, whether recognized by the British Pharmacopœia or not, when such drugs are not sold in a shop or place where medicines recognized by such Pharmacopœia are dispensed on prescription."

Calcutta Municipal Consolidation Act, section 368.—"No shop or place be kept for the retail sale of drugs not being also articles of ordinary domestic consumption, unless the same shall have been registered in the office of the Commissioners. Any keeper of such shop or place failing to register the same within two months of the passing of this Act, or within two months from the date of the establishement of such place, shall be liable to a fine not exceeding Rs. 100. The Commissioners shall, upon registration, grant the keeper of such shop or place a license, which he shall be bound to display in some conspicuous part of his premises.

"No persons shall compound, mix, prepare, dispense or sell any drug in any such registered shop or place, unless he be duly certified as a fit person to be entrusted with such duties under rules made for that purpose by the Local Government.

"Any person not being a holder of such certificate, who shall compound, mix, prepare or sell any drugs, in any such registered shop or place, shall, on conviction before a Magistrate, be liable to a fine not exceeding Rs. 50 for each offence, and any owner, occupier or keeper of any such shop or place who shall employ any such uncertified person to perform any one or more of such duties, shall, on conviction before a Magistrate, be liable to a fine not exceeding Rs. 200, and shall be further liable, at the discretion of such Magistrate, to forfeit his license.

"Nothing in this section contained shall be construed to apply to the sale of drugs used by practitioners of indigenous medicine when such drugs are not sold in a shop or place where medicines are dispensed upon prescription."

No objection of any kind can reasonably be advanced against an Act directing the registration of shops engaged in the sale of medicines and the employment therein of properly qualified persons. Measures of this kind are enacted, not only in order to obtain the accurate compounding of medicines, but also in order to avoid those mistakes which arise from errors in the identification of drugs. No doubt the operation of the Act in question has been to greatly minimise the risks arising from ignorant or careless compounding, so far as the majority of the British Pharmacopœia drugs are concerned. But the number of people benefited thereby is comparatively small. For even in the towns, a very large proportion of the people, when sick, are treated by means of indigenous medicines. It would naturally be surmised that the sale of all medicines ought to be attended with a certain amount of care. Why then are indigenous drugs exempted from the operation of the Act? A poison does not cease to be a poison because it happens to be excluded from the British Pharmacopœia. As already stated, the Act applies to British Pharmacopœia drugs only. There are, however, certain drugs common both to the British Pharmacopœia and to the indigenous list, among them being *aconite, nux vomica* and certain *arsenical* and *mercurial preparations*. The drugs common to both lists are specially exempted from the operation of the Act, provided they

are not sold in shops where British Pharmacopœia drugs are dispensed on prescription. One is prompted to ask whether such drugs, as *aconite* and *arsenic* change their character with change of locality, and whether they cease to be dangerous when dispensed without the help of a prescription. The special exemption of indigenous drugs from the restrictions imposed by the Municipal Act was, no doubt, made with the wise object of interfering with the practice of indigenous medicine as little as possible. But the practice of indigenous medicine does not consist solely in the adminsitration of poisons, and it will not be interfered with if the sale of deadly poisons is entirely removed from the hands of the ignorant *bunniahs* and *badias* and entrusted, where necessary, to the practitioners of indigenous medicines themselves. The provisions of the Act, in its present form, are difficult to enforce, as it contains no schedule of European drugs, which may be sold by *bunniahs* on the supposition that they are utilized in the practice of indigenous medicine. It is reported that, as a consequence of this, a large sale of European drugs is carried on in some *bunniah's* shops. In Calcutta, there is a very considerable wholesale trade in European and other drugs, in addition to the retail trade of the chemist's and *bunniah's* shops. The wholesale dealers reside chiefly in Burrabazar and Chandney, and carry on their business subject to no restrictions whatever. *White*

arsenic, chloral hydrate, hydrocyanic acid, morphine and *strychnine* may be purchased at one of these wholesale dealer's shops in large quantity by any individual however unfitted to be in possession of poisonous drugs.

It may be said that the wholesale purchase of medicine, even for domestic use in cases of sickness, is the common practice among the educated inhabitants of the large towns of Bengal, provided no compounding is required. A private person, when directed by his medical adviser to take a certain medicine, or when taking a medicine on his own responsibility, usually purchases a considerable quantity at one time from a retail or wholesale druggist, without of necessity presenting a prescription. In such instances, the dose is measured by the individual at his own home and not by the chemist. Provided the drugs bought and sold in this manner are not in any sense poisonous, no very serious objections can be raised to the plan, which is in addition apparently ratified by the approval of medical practitioners. But in the case of poisonous drugs, no more dangerous plan could be imagined. For at the present time, there is no law in India regulating the quantity of a poisonous drug which any single person may be permitted to purchase at one time, except in the case of opium where the quantity is limited to two ounces, or enough to poison, it may be, twenty individuals. Consequently, individuals addicted to the use of

morphine, chloral hydrate, or any other drug, find in India no difficulty in procuring any quantity of the drug for which they have acquired a craving. Needless to say, this is only one type of mischief resulting from the present system. If the wholesale druggist was permitted to sell poisons to authorized licensed persons only, and the retail druggist might sell poisons only on prescription, much of the mischief at present being wrought would be prevented. At the present time, the retail druggist may do a wholesale business in poisons or other drugs without let or hindrance, provided he has the purchasers. Such being the present condition of the trade in drugs, notwithstanding the enactment of legislative measures, it may now reasonably be urged that these measures require amendment.

(2) *Present proposition.*– The measures we propose may be summarised as follows :—

(A) An Arsenic Act. (B) The amendment of those sections of the Bengal Municipal Act and Calcutta Municipal Consolidation Act which relate to the sale of drugs. (C) The amendment of those sections of the Opium Act I of 1878 which relate to the retail sale of opium.

(A) The Arsenic Act.—As already stated, the *arsenic* in India is almost entirely imported into the country. By the courtesy of Mr. C. A. Samuells, Officiating Collector of Customs, Calcutta, we are enabled to furnish the following statement showing the imports and exports of arsenic at the Port of Calcutta during the last twelve years :—

TABLE V.

Statement showing the quantities of Arsenic imported and exported into and from Calcutta, in the Foreign Trade, during the official years from 1882 3 *to* 1893-4

Countries whence imported from and whither exported to.	1882-83	1883-84	1884-85	1885-88	1888-87	1887-88	1888-89	1889-90	1890-91	1891-92	1892-93	1893-94
	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.
IMPORTS. From												
United Kingdom	869	50	546	427	77	314	303	253	402	255	522	330
Germany, Hamburg	..	..	..	..	..	..	..	..	20	..	11	137
China, Hongkong	19	27	..	15	12	7	21	41	88	53	15	113
Straits Settlements	39	198	445	19	42	80	102	288	20	192	295	205
Australia, Victoria	..	2	..	..	..	..	..	..	..	..	..	..
Total ..	754	377	990	461	131	401	426	582	530	500	843	785
EXPORTS. To												
Ceylon	..	13	13	..	..	..	..	..	..	..	..	8
Java	..	..	..	17	..	..	..	..	..	..	..	..
Straits Settlements	228	34	70	175	106	161	154	119	..	195	60	127
Total ..	226	47	83	192	106	161	154	119	..	195	60	133

From the statement, it will be seen that a very considerable quantity of arsenic remains in the country. Last year, the quantity was thirty tons. The fatal dose of *arsenic* for an adult is two grains. How then, some might say, is the poisoning by *arsenic* to be prevented, when it is such a deadly drug and when such large quantities are annually imported? But thirty tons is a small quantity compared with the 2,875 tons which constitute the average annual output of *white arsenic* at the tin works of Tavistock in Cornwall; yet fatal *arsenic* poisoning of a criminal kind is not as a consequence frequent in the neighbourhood of Tavistock. The larger portion of the *arsenic* imported into India is used in trade, such as the cleansing and preparation of hides, paper, paint, wooden posts etc., and occasionally also for agricultural purposes. The yellow variety of arsenic which contains from twnety to thirty per cent. of white arsenic is used as a pigment and largely as a depilatory.

Without presuming that the proposition is complete and free from defect or couched in the proper legal pharseology, the regulations of the sale of *arsenic* which we would propose take the following shape:—

That certain indicidudls or officials shall be entrusted by Government with the duty of granting licenses for the import, sale, purchase and possession of arsenic after having ascertained to their satisfaction that the applicants for such licenses

are fit and proper persons to be granted the same.

That no arsenic or arsenical preparation recognized as a poison shall be bought or sold without a license except on the prescription of a licensed medical man with certain exceptions relating to the practice of indigenous medicine to be hereafter specified.

That persons desiring to import arsenic into the country must obtain a license authorizing its import, and must undertake to keep the arsenic in safe custody and to sell it only to persons producing a license authorizing them to purchase arsenic, all such sales being registered with an entry of the date, the quantity sold and the name and address of the purchaser.

That dealers in arsenic, whether wholesale or retail, must obtain a license authorizing them to buy, sell and possess arsenic, that they must undertake to buy from and sell to licensed persons only and to carry on their business generally under the same conditions as the importers, except in so far as its sale on medical prescription is concerned.

That persons requiring arsenic for manufacturing and other purposes not being those of sale, retail or otherwise, must obtain a license authorizing them to buy and possess arsenic for such purposes and must be prepared to satisfy the licensing authorities that they are fit and proper persons to be entrusted with the possession of arsenic, and that they are in a position to make suitable provisions for its safe custody both during use and at other times.

That in rural districts, and where necessary in towns, the practitioners of indigenous medicine if of good character may be licensed to buy and possess a limited quantity of arsenic only in each year and to dispense the same to their patients.

That pounded white arsenic, except in special cases hereafter to be determined, be sold mixed with soot or indigo in the proportion of one ounce to each pound of arsenic.

(B) Amendment of those sections of the Bengal Municipal Act and Calcutta Municipal Consolidation Act which relate to the sale of drugs:—

That the drugs named in the following lists to be known as Schedule A (European Poisons) and Schedule B (Indian Poisons) be considered as poisons for the Purposes of the Act:

SCHEDULE A.

European poisons.

1. Arsenic and its preparations.
2. Mercury and its preparations.
3. Antimonial preparations.
4. Strong Ammonia.
5. Strong acids such as concentrated Nitric, Sulphuric, Hydrochloric and Oxalic.
6. Phosphorus.
7. Hydrocyanic Acid and Cyanides.
8. Opium, its alkaloids and preparations.
9. Belladonna, Datura, Hyoscyamus, their alkaloids and preparations.
10. Nux Vomica, its alkaloids and preparations.
11. Aconite, its alkaloids and preparations.
12. Hydrate of Chloral.
13. Chloroform.
14. Carbolic Acid.
15. Cantharides and its preparations

SCHEDULE B.

Indian poisons.

1. White Arsenic (Senko, Semulkhar).
2. Red Arsenic or Realgar (Monchhal).
3. Yellow Arsenic or Orpiment (Harital).
4. Corrosive Sublimate (Raskarpura).
5. Aconite (Mitabish).
6. Datura.
7. Hyoscyamus (Khorassani Ajwan).
8. Nux Vomica bark or seed (Kuchila).
9. Plumbago rosea (Lalchitra).
10. Croton Seeds (Jaipal).
11. Yellow Oleander (Kolkaphul).
12. Cocculus Indicus (Kakmari).
13. Nerium Odorum (Karabi).

That in the same manner as suggested for the sale of arsenic, lincenses be granted for the sale and possession of poisons.

That except under certain conditions and in certain quantities to be specified in each case, no poison within the meaning of the Act shall be bought or sold without a license except on the prescription of a licensed medical man.

That persons engaged in the merchandise of poisons as defined by the Act must obtain a license authorizing them to carry on such business, and must undertake to conform with the provisions of the Act and not to sell poison in any quantity larger than that permitted for its retail sale other than to duly licensed individuals, except on medical prescription.

That every sale of poisons except on medical prescription with certain exceptions relative to the practice of indigenous medicine must be duly registered in the following manner :—(a) Name of purchaser. (b) Residence of purchaser. (c) Object of purchase. (d) Authority for sale. (e) Quantity sold. (f) Date of sale. (g) Signature of the seller. (h) Signature of the purchaser.

That no person shall be permitted to buy and possess poisons who is unacquainted with their nature, and is not in a position to make proper arrangements for their safe custody and sale.

That, in the shops of individuals licensed to sell poison, the poisons are to be properly labelled with the name of the poison and the printed word POISON both in English and Vernacular and

kept apart from other articles of merchandise.

That in rural districts, and where necessary in towns, practitioners of indigenous medicine, if of good character, may be licensed to buy and possess and dispense to their patients limited quantities of the poisons included in Schedule B.

That all practitioners of medicine licensed to prescribe or dispense poison be registered.

That the same regulations should apply to persons requiring poisons for manufacturing and other purposes not being those of sale, as were recommended in the case of arsenic.

That it may be advisable to permit a limited retail sale of certain of the poisons included in the Schedules for domestic and other purposes, and that the drugs which may be sold, the quantities to be sold and the manner of the sale be hereafter determined.

That all patent and proprietary medicines, if found to contain poison within the meaning of the Act, come within the operation of its provisions.

(C) Amendment of those clauses of the Board's Excise Opium Form No. 1 which relate to the retail sale of opium:—

At the present time, the largest quantity of opium that may be purchased from an opium vendor on one occasion by any single individual not being a licensed druggist or licensed vendor of opium, or of an intoxicating drug is five

tolahs or two ounces.* This quantity is fixed by the Board's Excise Opium Form No. 1 as the extreme limit of retail sale. Two ounces of Indian opium are sufficient to poison from fifteen to twenty individuals, provided that they are not opium-eaters. Attention has already been drawn to the disastrous results of this system. The largeness of the quantity selected as the limit of the retail sale was, no doubt, due to the wish of the authorities to interfere as little as possible with the requirements of the opium-eater, and with use of opium as a domestic medicine. If the extreme limit of the retail sale of opium were fixed at one-eighth tolah or about twenty grains, no interference with its use as a domestic medicine would arise, as this quantity represents from twnety to forty ordinary medicinal doses. Twenty grains is, however, for an adult less than the minimum fatal dose of Indian opium, which is much less potent (five times less at least) than Turkey opium. Such a limit would also satisfy the requirements of a very large number of opium-eaters. The daily dose of opium eaten at the commencement of the habit is about half a grain, a quantity which, as is well known, undergoes gradual increase until a very much larger amount, even 100 grains daily, is ingested. But a very considerable

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* That he do not, except to a vendor of opium or of an intoxicating drug licensed by the Collector or to a licensed druggist, sell more than five tolahs of opium to any person at one time.

proportion of pronounced opium-eaters never exceed fifteen to twenty grains per diem, and endeavour to subdue the craving for a larger quantity. The question now naturally arises as to how and where, if the retail limit be fixed at twenty grains, is the opium-eater, whose daily dose exceeds this quantity, to get his daily supply. The answer is a simple one. Either the opium-eater must be exposed to a trifling inconvenience in order to get the quantity he requires, or the danger to the general community at present existing must continue.

At the present time, opium-eating is not to be regarded as a vice in any sense of the term, but only as a habit, the excessive gratification of which engenders very serious dangers to the community at large if it requires that large and fatal doses of opium must be sold without restriction.

It is not too much to require of the opium-eater, whose daily dose has exceeded the retail limit, that he should provide himself with a certificate to that effect signed by a medical man or a respectable individual, such as the headman of his village. We would suggest that such certificates should state the daily dose required, and should be valid for one year only, and that the opium vendor, on the presentation of a certificate of this kind, should be authorized to sell the quantity intimated therein, provided it does not exceed five tolahs.

The proposed amendment of the Board's Excise Opium Form No. I is accordingly as follows :—

That he do not except to a vendor of opium or of an intoxicating drug licensed by the Collector, or to a licensed druggist sell more than one-eighth tolah of opium to any person at one time except on the production of a certificate stating that the purchaser is an opium-eater, signed by a licensed practitioner of medicine or a respectable resident of the locality, when the quantity specified in the certificate, provided it does not exceed five tolahs in weight, may be sold.

All sales exceeding one-eighth tolah to be entered in a special printed record giving in addition to the information required in para XVI of Form No. 1, the name and residence of the purchaser, the authority for the sale, and the quantity sold.

(3) *Difficulties attending the introduction and working of such a measure :*—Numerous objections suggest themselves; therefore, it may be as well first to enumerate those which appear most important and then subsequently deal with them in detail. The following are the objections which will be considered: (*a*). That no practical decrease in poisoning will result by imposing restrictions on the sale of certain poisons while others being indigenous to the country must perforce remain easily accessible. (*b*). That any change which may arise from the proposed measures will be

distinctly a change for the worse on the ground that vegetable poisons will, after the enactment of such measures, be utilized to a greater extent than at present, and that such poisons are more difficult of detection than the mineral poisons now in use. (*c*). That the proposed measures would necessitate an undesirable amount of interference with the domestic habits and customs of the people of the country. (*d*). That they would interfere with the practice of indigenous medicine and thereby deprive the people in many districts even of the small amount of medical aid which they can obtain at the present time. (*e*). That measures of the kind proposed would interfere with trade and many useful economic practices.

Without attempting to raise the question, whether the policy of temporizing with an admitted evil is correct, we would at once ask, what are the poisons which may be expected to take the place of *arsenic*, *aconite*, *opium* and other controllable poisons if these are rendered more or less inaccessible. If any such exist, they must naturally be sought among the indigenous drugs of the country, which belong for the most part to the vegetable kingdom. That the country has many vegetable products endowed with poisonous properties is easily learned by reference to the "Pharmacographia Indica" written by Dymock, Hooper and Warden. Fortunately, however, the knowledge of the poisonous properties of the majority of these

substances is not yet by any means popular. They may, in consequence, be considered rather as potential than actual poisons at the present time, so far as the people generally are concerned.

As judged from general information, and from all the cases of poisoning which are reported, the number of indigenous vegetable poisons commonly known is very small. The following are the chief: *Opium, datura, aconite, nux vomica, oleander, abrus precatorius.* Opium heads the list, and is responsible for more fatal cases of poisoning than any other drug, but, as already shown, its accessibility can be controlled without imposing hardship on those who require it for a legitimate purpose. Successful interference with the possession of *datura* is apparently hopeless. Fortunately, the uncertainty of its action is tolerably well recognized. It is in consequence ill-suited to the murderer's purpose, as great risk of detection would be incurred should the poisoned man recover. The murderer does not of necessity desire to leave the locality of the murder; the robber, on the other hand, administers *datura* to assist him in the act of theft and to cover his flight with the booty. *Datura poisoning* is chiefly non-fatal. *Aconite* like *arsenic* is an imported poison, and though its introduction into the country cannot be so easily controlled as that of arsenic, yet, as the channels of introduction are well-known, a feasible plan to prevent the widespread dis-

semination of the drug should be practicable. The physiological symptoms set up by the chewing of even a small fragment of *aconite* root are a bar to its frequent use as a poison, and have frequently assisted in the discovery of the poisoner. *Nux vomica* trees can hardly be said to grow wild in this part of India in the same way as *datura*. They are to be found here and there, and have generally been planted for some purpose. Nux vomica seeds can, however, be readily purchased in the bazar. One seed is sufficient to poison an individual, and one tree may produce many hundreds of seeds. As nux vomica trees are not numerous, and do not grow wild, their cultivation, except in certain recognized places and by authorized individuals, should be prohibited. The cases of poisoning which arise from the use of *oleander* are, for the most part, accidental. The plant is to be found in most gardens, and like *datura*, it is a poison which cannot be removed from the reach of the poisoner. Its poisonous properties do not seem to be very widely known, and its action is some what uncertain. The method of using *abrus precatorius* seeds has already been referred to. The fact that it requires to be introduced subcutaneously is an efficient hindrance to its employment other than in a limited number of cases of cattle-poisoning. These then are the poisons which have been in use for half a century and more. The accessibility of three of them, *viz.*, *opium*,

aconite and *nux vomica* can effectually be controlled. *Abrus precatorius* is seldom used, and then only as a cattle poison. *Datura* and *Oleander* remain, but their use (oleander, for homicide or suicide) is rare now, for the reasons already given, and for those reasons is not likely to become more prevalent. It is, of course, very difficult if not almost impossible, to foretell what altered conditions may bring about; but as for many years there has been practically no apparent attempt among poisoners to strike out a new line, it may reasonably be hoped that the introduction of a restricted poison sale would, for several years, enforce a sensible diminution in this class of crime. It is of some interest to note, that so long ago as 1843, Dr. Mouat, then Chemical Examiner, considered that the use of vegetable poisons was on the increase, and wrote as follows :—

"The great majority of cases of the administration of poison had hitherto been arsenic. Lately, however, the exhibition of vegetable poisons has been more resorted to from its being known to *hakims* and native druggists that, while minute traces of any mineral poison can be unerringly detected, most vegetable substances defy analysis in the present state of chemical science. Some check ought to be put to the amount of murder committed in this way, unknown and unrecorded, by legislative enactment, punishing all vendors of drugs in whose possession those substances are found."

Dr. Mouat's apprehension have, however, proved groundless, for Dr. Warden, referring to this statement, was able to state in 1886 :—

"The above was written about forty years ago; the fear expressed that *vegetable poisons* might supplant *arsenic* has not been verified. *Arsenic* is still the homicidal and cattle poison of India."

It will naturally be advanced that from Dr. Mouat's time up to the present, *arsenic* has remained easily accessible, and the necessity for discovering suitable vegetable poisons has not arisen. But even should the properties of indigenous vegetable poisons become generally known, these substances could never compete with *arsenic* in fitness for the poisoner's purpose. A comparison of the properties of *arsenic* and *vegetable poisons* as a class, will at once indicate the advantages which attend the use of *arsenic.*

Properties of *arsenic* and *vegetable poisons* generally :—

Arsenic.	*Vegetable Poisons.*
1. Tasteless.	1. Acrid, bitter or unpleasant taste.
2. Certain in action.	2. Uncertain in action due to the varying quantity of the active principles present in different specimens of the same plant.
3. The fatal dose is a small quantity.	3. To cause death, larger quantities are necessary of the majority of crude vegetable drugs.
4. Simulates in a remarkable manner the symptoms due to natural disease.	4. Do not simulate the symptoms of disease to anything like a corresponding extent.

The certainty of its action, its want of taste, the smallness of its fatal dose (two to three grains) require no further comment. They alone would give to *arsenic* a place in the front rank of the poisoner's equipment in any country. But the similiarity of its symptoms with those induced by disease gives it in India a special value which is well illustrated by the following case:—On October 28th, 1894, a man was admitted into the Mayo Hospital, Calcutta, suffering from symptoms of choleraic diarrhœa. He arrived alone and stated that he had come from Moorshedabad by steamer, having purchased and eaten food in the bazar before leaving. He became ill on board the steamer. After admission, his symptoms were attributed by one of the medical officers to *arsenical poisoning*, but by three others, who also examined the patient from time to time, he was considered to be suffering from choleraic diarrhœa. The man died on the fourth day after admission, and a *post-mortem* examination was held. The condition found was one of general congestion of the alimentary canal with ulceration of the stomach and ecchymosis over the columnæ carneæ of the heart. Portions of the viscera were sent to the Chemical Examiner for analysis which revealed the presence of *arsenic*. It is legitimate to expect that many similar cases occurring in the district are returned without challenge as cases of cholera, if such a diversity of opinion can arise in a

hospital provided with an experienced and expert medical staff. We have reason to believe, as already stated, that acquaintance with the vegetable poisons of the country and knowledge of their properties are not by any means widely diffused, even among the rural population. On the other hand it is, of course, quite impossible to determine what the practical knowledge of *hakims* and Indian druggists may be as regards indigenous vegetable poisons. In 1843, Dr. Mouat suggested that *hakims* and Indian druggists were beginning to put their knowledge to a criminal use. Whether this holds good at the present time, and to what extent, we are quite unable to say. In towns, the practitioners of indigenous medicine are, as a class, a respectable body of men. No doubt here and there, black sheep are to be found among these who are not over scrupulous as to the methods in which they earn money. But should the scheme proposed be put in force, these people will be dependent for a supply of drugs very important if not essential to them in their practice upon the evidence of good character and conduct which they can adduce. In future, these men would possess a definite status. A recognized position and the discharge of responsible duties are often sufficient to deter criminal instincts from the abetment of commission of crime.

Without implying that the detection of a vegetable poison is as certain as that of a

mineral, it may yet be confidently stated that the chemical methods for detecting vegetable poisons have considerably improved since the time of Dr. Mouat's report already referred to. And though there is still room for further advance in this direction, much has been done, and vegetable poisons can be detected by chemical analysis of viscera with a very considerable degree of certainty, as compared with the results of fifty years ago. Should resort to indigenous vegetable poisons be stimulated by restrictive measures, it is probable that chemical research into the nature of these poisons, and the best methods of detecting them, would also be stimulated. Much has already been done in this direction by Dymock, Hooper and Warden.

If the proposed measures be carefully reviewed, it will be seen that special cognizance has been taken of customs and habits, and the measure so drafted that no undue interference with habits and customs can arise. In the measures to restrict the general sale of poisons, a special clause is introduced to legalize a small retail sale to unlicensed persons, the provisions of the clause to be hereafter determined.

The practitioner of indigenous medicine will not be interfered with in his practice, but will be recognized and registered; he will, so far as the general community are concerned, become a more important, a more responsible individual than heretofore. We are aware that

the proposal to register the practitioners of the province, has already been once made, and that it was abandoned on account of the difficulties of the task.* We are now, however, approaching the matter from a different standpoint. It is utterly impossible to conceive of any scheme for restricting the sale of poisons, unless a register is kept of those persons to be entrusted with certain privileges with regard to poisons. A licensed or registered medical practitioner is the only individual in most countries who is allowed to prescribe, sell or possess poisons without challenge, and without having to keep a list of the quantity of poisons prescribed and sold by him in the discharge of his duties. The obligation to register his name and address is a very small matter indeed in return for such important privileges, nor need the Act of registration be made unduly vexatious. All medical practitioners in the employment of Government are already registered by the Imperial and Provincial Governments, and there would be no necessity to trouble them in any way. In Calcutta, all practitioners of medicine have to obtain a license from the Municipality, permitting them to practise, and this would simplify the registration of medical practitioners in Calcutta very greatly. In small towns and rural districts, registration must of necessity

* A Medical Registration System has since been introduced in this country. EDITOR.

be a very gradual process. It would follow on the exhaustion of the stock of poison in the possession of the practitioner of indigenous medicine and the necessity of obtaining a license before it could be replenished. A measure of this kind can only very gradually be brought into force among a population such as that of the province of Bengal. Numerous difficulties would, no doubt, be encountered in its introduction, and the full measure of benefit to be derived from its operation would only slowly be realized. But, on the other hand, without some such scheme of registration, the restriction of the sale of poisons seems impracticable.

Interference with trade will practically arise only from restricting the free sale of arsenic. The value of the average annual quantity of arsenic imported into the country at the Port of Calcutta during the last ten years has been about £308 sterling, valuing the arsenic at £14 per ton. The value of the average annual number of animals poisoned by arsenic in the province of Bengal only during the same period may be calculated as about £180 sterling. A certain amount of annoyance must of necessity be experienced in certain trades and occupations on the introduction of a restricted sale. It is possible that certain individuals who are now in the habit of using arsenic in their trade may be unable to obtain it in the future. Such objections should not, however, be allowed to

carry any force. The convenience of the few can hardly have weight when the interests of a population have to be considered. Those persons who are fit to be trusted with poison will be able to obtain it under conditions of restricted sale as readily as at the present time. They will, moreover, have opportunities of realizing that they are responsible for the safe care of the poison which they are permitted to buy. The value of the arsenic imported into the country at the Port of Calcutta does not indicate that any important industry would be injured by the proposed measures.

We have now reviewed those objections to the introduction of measures restricting the free sale of poisons which appear to us to be the most important. For many years past, the introduction of such measures has been frequently recommended. It is trusted that the sketch given in our paper of the present prevalence and nature of poisoning in the province of Bengal may serve to demonstrate that the necessity still exists. Without underrating the difficulties attending the introduction and working of such a measure incident to the special conditions prevailing in India, we are confident that its introduction would be attended by great reduction in crime.

We do not pretend that the measures proposed by us are free from defect or incapable of improvement. The scheme, such as it is, is submitted for criticism.

In conclusion, we have to thank Dr. Simpson, Health Officer, Calcutta, Surgeon-Major J. B. Gibbons, I.M.S., Police Surgeon, Calcutta, Dr. Sasibhusan Ghose, Assistant to the Health Officer, Calcutta, Baboo Mohiny Mohan Chatterjee, Attorney-at-law, of the Calcutta High Court and Baboo Surendra Nath Mitra, B. A., Registrar, Bengal Secretariat, for information, and assistance in the preparation of the statistics contained in this paper.*

* This paper was read at the First Indian Medical Congress held at Calcutta in December, 1894, and was forwarded by the Committee of the Congress to the Government of India for consideration and for such action as they might think necessary to take in the matter. It formed the basis of the Poison Act of 1904. EDITOR.

Memorandum on the use of a Saturated Solution of Common Salt as a Preservative for Viscera Sent for Chemical Examination.*

1. In accordance with the Bengal Government Circular letter No. 2792, dated 9th August 1878, human and animal viscera in suspected cases of poisoning are sent for chemical examination ordinarily preserved in spirits of wine; sometimes country liquor is substituted for spirits of wine, but the result is unsatisfactory in such cases, for, as a preservative, country liquor is not an efficient substitute for spirits of wine. In a certain number of cases, however, the quantity of alcohol used is insufficient to cover

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* Indian Medical Gazette, March, 1897.

Note.—The memorandum was submitted to the Government of Bengal and the Author's suggestions were accepted. Saturated Salt Solution has since been in use in the Provinces of Bengal, Bihar, Orissa and Assam for the preservation of cattle viscera and of human viscera in certain cases.—EDITOR.

the viscera fully; the exposed parts consequently undergo decomposition to the great inconvenience and risk to health of the officers in the Chemical Examiner's Department who have to work for days with the stinking viscera. The evil may easily be remedied by adding in all cases spirits of wine in sufficient quantity to cover the viscera to about an inch above their upper surface.

2. In cases of suspected alcoholic poisoning, perchloride of mercury in watery solution (1 in 1000) is employed as a preservative where alcohol for obvious reasons cannot be used. Owing to its weak strength, this solution as a preservative is of no value whatever, and the viscera thus preserved are always found to be in an advanced state of decomposition, stinking and disintegrated in shreds. The result of analysis is also unsatisfactory in these cases as when distilled for extraction of alcohol, certain volatile products of putrefaction come out which either interfere with or simulate some of the chemical reactions of alcohol.

3. The use of perchloride of mercury in strong solution as a preservative is objectionable on the following ground. In cases of alcoholic poisoning, it is always a practice not only to examine the viscera for alcohol, but also for other poisons as well. It not unfrequently happens that opium, datura and other poisons are detected in the viscera with or without alcohol in cases where death is reported to have

occurred from alcoholic poisoning. Perchloride of mercury has the property of forming with all vegetable alkaloids, compounds, which are insoluble in water, and when added to viscera in which a vegetable poisonous alkaloid is present, an insoluble compound of the poison with mercury is formed which is not taken up by the water used for the extraction of the alkaloid. The vegetable poison consequently remains undetected.

To obviate this difficulty, I have long been on the look-out for a preservative to be used in cases of alcoholic poisoning which will not only keep the viscera in a sound condition but also will not interfere with the extraction and chemical reactions of any poison contained in them.

5. As the result of a number of experiments, I have found out that a saturated solution of common salt is the best substitute for alcohol as a preservative, and that its use is unattended with objections which apply to perchloride of mercury.

6. By placing viscera freshly removed into such common salt solution, they were found to keep quite well when examined months afterwards. The tissues showed no signs of decomposition, were intact, and the odour was perfectly sweet, if not agreeable.

7. I have found common salt to be not only an antiseptic, preventing putrefaction, but also a good deodoriser. When decomposed offensive viscera have been put into common salt solution

and examined after a month, not only has putrefaction been checked, but the offensive odour has been found to have disappeared. In this respect, common salt acts better than alcohol which arrests putrefaction but has little influence in destroying the offensive odour of tissues already putrefied when put into it. This is a great advantage, as it often happens that bodies received for *post-mortem* examination are in an advanced state of decomposition, and the viscera in such cases, although sent preserved in alcohol, emit a fearful stink in the subsequent operations of boiling and evaporation required for the extraction of poisons, which is prevented by the use of saturated common salt solution.

8. My next attempt was to find out if common salt thus used was prejudicial to the detection of poisons present in the viscera. Theoretically there could be no objection, as common salt has no injurious action on any of the known poisons, and I proceeded to verify this by experiments. I accordingly added small quantities of alcohol, opium, morphine, nux vomica, strychnine, datura, and aconite separately to viscera not contaminated with any poison, and put each separately into common salt solution. After the lapse of a month, I examined them. The viscera in every case kept quite sweet, and the poisons added were successfully extracted from them.

9. The use of common salt as a preservative is not a novel suggestion. From very early times, it has been used to preserve meat and other articles of food. But as a preservative for viscera, I remember only one case, during the eleven years that I have been in the laboratory, in which the viscera were sent preserved in common salt solution.

10. The advantages that will accrue from the use of common salt as a preservative for viscera are :—

(*a*) It is equal, if not superior, to alcohol in its antiseptic properties, and certainly superior to perchloride of mercury in the strength in which this is ordinarily used.

(*b*) As a deodoriser, it is superior to alcohol and perchloride of mercury.

(*c*) It would be economical compared with alcohol, considering the large number of cases of human and animal viscera that are annually received in the laboratory. The animal viscera are invariably sent in large quantities with a correspondingly large quantity of alcohol as a preservative. In Bengal alone, 150 to 200 cattle viscera are annually received for examination; and as about the same number is received by each of the Chemical

Examiners in the other four Presidencies, the substitution of common salt for alcohol in these cases will cause a great saving in expenditure.

11. There is one drawback, however, in the use of common salt solution so far as human viscera are concerned, and that is, it forms a crust on the surface of the fluid extract of the viscera retarding evaporation during extraction of vegetable alkaloids by Stas's method. The crust has to be broken up constantly to facilitate evaporation, and this entails extra labour and some delay in the completion of the results. The above objection applies to human viscera only, and is certainly of importance considering the large number of them received annually in the laboratory, as any delay in the submission of the reports is likely to put officers engaged in the inquest to inconvenience. The objection, however, does not apply to cattle viscera, about 80 per cent. of which contain arsenic and require no process of evaporation.

12. Taking into consideration the facts stated above, *common salt* may safely be recommended as a preservative in place of alcohol and perchloride of mercury in the following cases :—

(*a*) In all cases of alcoholic poisoning.

(*b*) In those suspected cases of human poisoning in which the viscera at

the time of *post-mortem* examination are found in a state of putrefaction.

(*c*) In all cases of cattle-poisoning.

In all other cases of human poisoning, alcohol may with advantage be used as it is at present.

It may not be uninteresting to note that common salt obtained from various places have been examined and found to be free from poisons. As a preservative, *a saturated solution of common salt* should be used. The solution is prepared by adding cold water to excess of common salt, stirring as long as the water dissolves the salt and filtering the solution through a cotton-wool plug when it is ready for use. The solution keeps well for an indefinite time, and a large quantity may be prepared at a time to save trouble. It is best to put it in stoppered glass bottles. The bottle containing the viscera should be completely filled with the common salt solution.

The Bhowanipore Food-Poisoning Case.*

INTRODUCTORY REMARKS. It may be asked what necessity there was in writing a paper on the Bhowanipore food-poisoning case, when two reports had already been furnished to the public by Dr. Nield Cook, the Health Officer of Calcutta. Dr. Cook's first report on the case was written on the 9th July, 1903, about two weeks after the occurrence and subsequently, a supplementary report appeared in the Indian Medical Gazette of October, 1903, in which he made an attempt to substantiate the theory of bacterial infection of food-stuffs by an examination of the tank situated on the south-east side of the cow-shed in which most of the food-articles were stored on the three days of the feast. My apology for writing on the subject is, that having been personally one of the guests of the evening, and having suffered a great deal in consequence, I am in a position to speak from personal experience on certain points which may throw some additional light

* Calcutta Practitioner, January and February, 1904.

on the results of the enquiry already published. Another consideration which urges me to write on the subject, is that the importance and the singularity of the case require detailed treatment. Dr. Cook has stated in his second report, that food-poisoning is more common in India than it is generally believed to be. He, however, includes in his classifiaction of food poisoning, cases in which mineral or vegetable poisons are intentionally or accidentally introduced into food-articles. Such cases should not in my opinion be classed as cases of food-poisoning. Homicidal or suicidal poisoning cases, in which poisons are administered or taken with food, have not been classified by medical jurists as cases of food-poisoning. If these be included in the list, food-poisoning cases would be common in all parts of India. But if these be excluded as not being genuine cases of food-poisoning, such cases would be found to be comparatively rare, specially among the Hindu community. By genuine food-poisoning cases, I mean those in which symptoms of poisoning are produced either by the ordinary food-articles but of bad quality (such as diseased or putrid meat or fish), or by the use of certain poisonous vegetables and animals (such as ergot of rye, wild mushrooms and other poisonous vegetables, poisonous fish &c.), or by using food accidentally infected with some variety of pathogenic bacteria as has been suggested by Dr. Cook in the present case. Blythe in his

book on "Poisons, their Effects and Detection" devotes a chapter on food-poisoning. In it, he includes those cases only, which "are probably caused by ptomaines existing in the food before being consumed," or those "due to unhealthy fermentation in the intestinal canal itself" or those in which it is probable "that a true zymotic infection is conveyed and developed in the sufferer."

Cases of true food-poisoning are not at all common in Bengal. During my eighteen years' connection with the Bengal Chemical Examiner's Department, such cases have only occasionally been referred to this department. These were reported to have been caused either by eating wild mushrooms or certain poisonous tubers or grains which were mistaken for the innocent edible varieties, or by a kind of poisonous fish met with in certain districts of Bengal. But during these years, there was not a single case of the nature of the Bhowanipore case.

The reason why such cases are rare in this country is not far to seek. Pork, bad beef, sausages, tinned food, unboiled milk, rancid cheese, shell-fish, which are accountable for the majority of food-poisoning cases in Europe and America are only rarely, or not at all, used by the majority of the people of this country. The above considerations would, therefore, hardly justify one to subscribe to the opinion of Dr. Cook, that food-poisoning is more common in India than it is generally believed to be.

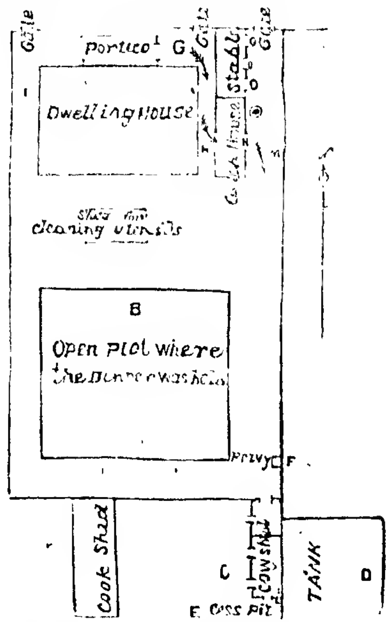
Another reason for my taking up the case is, that it is possible on closer examination to approach very near to the infected food, if not to accurately to fix upon it; and also to suggest a new source of its contamination other than put forward by Dr. Cook.

HISTORY.—Never was the Bengali Hindu society of Calcutta and Bhowanipore more greatly disturbed than during the week following the festivities which were held at the house of Mr. B. on the 26th, 27th, and 28th June, 1903. The cream of the Bengali Society was invited on the occasion: a large number of respectable families had their representatives of both sexes at the feast, one day or the other.

The festivities commenced on Friday, the 26th June, when about 100 ladies were hospitably entertained at dinner. It passed off without any disturbance. On the following day (27th June), about six hundred gentlemen dined in different batches between 8-30 p.m. and 11 p.m.; about one-fourth of this number suffered more or less from symptoms of acute gastro-enteritis, of whom four died. On Sunday, the 28th June, a limited number of friends (about 60) were entertained at a dinner party at about 9 p.m., which was, however, attended with no untoward results.

The guests dined on all the three days in a large piece of land to the south of the house, under a shed erected specially for the purpose. On the south-east corner, there is a pucca cow-shed,

C, which stands on the side of a tank, D, into which the cow-shed partly drains. There is a



Rough plan of the house.

pucca cess-pit, E, coated with Portland cement, outside the cow-shed very close to the tank into which part of the filth of the cow-shed is allowed to collect. In the opinion of the Municipal District Medical Officer of Bhowanipore, this

tank is one of the foulest in his jurisdiction. The cow-shed has two compartments, one having two windows opening direct towards the tank, and the other having none on that side.

The cow-shed was used on each of the three days, for storing prepared food-articles, the cows having been removed two or three days earlier. It was reported to have been lime-washed and disinfected with phenyle before its use in this way. To the north of the cow-shed at a short distance, stands a service-privy, F, used by the servants, the condition of which has been reported as very insanitary by the Medical Officer. The admission from the house into the open plot of land where the feast was held is through a coach-house, G, on the east side of the house and parallel to it, there being an open pathway, H, a few feet wide, between the house and the coach-house. The stable, I, is adjoining to the coach-house on its north side, there being a pucca partition wall between the two in which there is no opening. There is an open space, M, on the east of the stable and the coach-house, continuous with the plot of land where the feast was held. Here horses used to be groomed and then taken into the stable through the doors, O, on its east wall and in a line and close to another door, N, which serves as an exit from the coach-house. The guests had to pass through the door, N, to come to the dining shed. Between the doors of the coach-house and the stable (N and O), part of the ground was covered

with Portland cement and here it was at the spot marked in the plan with a black dot that ice-cream was prepared which the guests who had to pass by the way must have noticed.

The menu of the Saturday dinner consisted of loochis, vegetable, curries, dal, various preparations of fish, prawn and meat (chops, cutlets, kabab, kopta, korma, curry) and Polao, dahi, rabri, rich pudding prepared with chhana, milk and sugar, chutney, sweetmeats of various sorts, fruits such as mangoes, and ice-cream.

The articles of food distributed on the occasion were with few exceptions of good quality.

NUMBER AFFECTED: SYMPTOMS AND CASES :— From the report published in one of the vernacular weeklies, we gather that about one hundred persons among the guests suffered severely and had to keep away from work for periods ranging from two days to about a fortnight. Four of these cases are known to have ended fatally. About 100 persons more developed mild symptoms such as slight diarrhœa, feverishness, disinclination for food and weakness which passed off in a day or two without much inconvenience to the sufferers. Nearly all the cases did not develop any symptoms before the noon of the next day. A few persons felt uneasy immediately after the dinner and got relief by throwing up the food and escaped further troubles. Most of the victims felt all right on Sunday morning and took their bath and

breakfast as usual. It being a Sunday, many of them had not to attend their places of business, but a few went out of the town on pleasure-trips and others attended to their professional and other duties. I myself felt all right on Sunday morning, went out to see a patient and took my bath and breakfast as usual. At about 1 p.m., I had a loose motion followed by another in about an hour's time. I went out at 2-30 p.m. to attend a public engagement and while engaged in the work, I felt very chilly, my eyes began to burn and I got slight headache. I felt my pulse; it was full and bounding. I had to work upto 8-30 p.m. I had fever all this time. On returning home, I passed a very loose stool; diarrhœa continued during the night; the fever also kept on. I did not suffer from any griping pain in my bowels at the commencement of the attack, but I had it in a severe form afterwards. The fever left me on Tuesday noon but the diarrhœa kept on for ten days. With the exception of the first 2 or 3 days, the motions were accompanied with severe griping. The motions consisted of dark-green shreds and flakes of mucus but in the whole course of the disease, no blood was detected in them. They were very offensive and caused heat and burning pain when passed. They were invariably mixed with a considerable amount of froth. On the third day of the attack, I began to feel very weak, scarcely able to walk a few paces without support. On the morning of the fourth day,

I felt very weak and experienced a sinking sensation; profuse cold perspiration continued for a few hours; the pulse became much depressed; the extremities grew cold; there were signs of collapse. By the afternoon, I felt much better and recovered from this shock. I may state here that a severe family disaster took place on that day early in the morning, in the death of a young nephew of mine who fell a victim to this feast. This might have accounted for my depressed condition on Wednesday morning. I had no nausea and never vomited in the course of the attack.

Through the kindness of Drs. Adya Nath Bose, Hira Lal Bose, Bipin Behari Ghose and Babus Kalidas Roy Chowdhury, and Bejoy Lal Dutt, I have been able to collect 36 cases. The symptoms in most of these cases corresponded closely to mine. I made special enquiry as regards the kinds of particular food-articles taken by these persons in order to fix, if possible, upon the infected food. I believe a careful perusal of these cases will help us in eliminating the innocent from the infected food-stuffs and also give us a clue to the probable source of its contamination.

I may mention that the guests dined in different batches one after another, the 1st batch at 8-30 p.m., 2nd at 9-30 p.m., and the 3rd batch, subsequently.

Case No. 1.—B. K B., aged, 17 years. Dined with the first batch, took all the dishes

and plenty of *ice-cream*. At 11 a.m. next day after breakfast felt uncomfortable, had a loose motion. Shortly after, had shivering and head-ache followed by fever—103° F. From 11 a.m. to 4 p.m. had five loose stools, and at about 4 p.m. vomited for the first time bringing up the undigested rice he took at his breakfast; had no more vomiting but nausea and severe retching. He continued from Sunday to Monday in the same condition, having 7 or 8 loose stools daily. Fever left on Tuesday but the diarrhœa, nausea and retching continued till Saturday. There was great prostration, so much so that he was unable to get up from his bed. He experienced griping pain all along. There was no delirium, cramp or collapse. Stools were thin, yellow and later, contained mucus. No suppression of urine. *Incubation period*—15 *hours*.

Case No. 2.—B. C. S., aged 18 years. Took a large quantity of *ice cream* and other foods as well. Premonitory symptoms:—lassitude and loss of appetite. Onset with diarrhœa; vomited once. Stools thin, watery, yellow or green, containing a good deal of mucus. Shivering and fever, temperature 104.5° F. Delirium, collapse and coma. DEATH. *Incubation period*—17 *hours*. Temperature rose to 106° F., four hours before death. Suppression of urine—12 hours before death.

Case No. 3.—M. R. M., aged 31 years. Took all the dishes and the *ice-cream*. Premoni-

tary symptoms:—lassitude and no desire for food. Onset with diarrhœa. Vomiting. Shivering with fever, temperature 103° F. Great weakness. *Incubation period*—14 *hours.*

Case No. 4.—R. C. C., aged 58 years. Took all the dishes and the *ice-cream.* Onset sudden, shivering with fever, temperature 105.6° F. No vomiting, colicky pain, diarrhœa. Loss of speech, coma, delirium and *death. Incubation period*—14 *hours.*

Case No. 5.—D. N. N., aged 23 years. Took all the dishes and the *ice-cream.* Onset sudden with diarrhœa; vomiting; collapse. Recovery on the eighth day. *Incubation period*—15 *hours.*

Case No. 6.—N. N. D., aged 40 years. Onset sudden with fever. Took all the dishes and *ice cream.* Shivering. No nausea or retching. Vomiting and diarrhœa. Recovery. *Incubation period*—20 *hours.*

Case No. 7.—N., aged 36 years. Onset sudden with diarrhœa; vomiting severe. Took all the dishes and *ice-cream.* Shivering and fever. Temperature 105° F Recovery. *Incubation period*—14 *hours.*

Case No. 8.—S. C. B., aged 42 ayears. Took *only ice-cream.* Onset with diarrhœa; no vomiting. Fever with shivering. Temperature 103° F. Slow recovery. *Incubation period*—3 *hours.*

Case No. 9.—P. C. B., aged 30 years. *Took ice-cream only.* Premonitary symptoms:—heaviness and pain in the stomach. Onset with vomiting and diarrhœa; severe griping.

Stools watery and green. Cramps and collapse. Slow recovery. *Incubation period* 9 *hours.*

Case No. 10.—A. K. K., aged 25 years. Took a little of every thing including *ice-cream.* Onset with chilliness and fever, temperature 102° F. Severe diarrhœa 60 hours after the dinner; stools thin and very offensive. Extreme weakness; recovery slow. *Incubation period—* 24 *hours.*

Case No. 11.—R. R. C., aged 28. Took all the dishes including *ice-cream.* Onset sudden with diarrhœa; no vomiting; fever, temperature 100° F. Stools thin, yellow and offensive; no griping. Great weakness. *Incubation period—* 33 *hours.*

Case No. 12.—A. T. B., aged 46 years. Took all the dishes except meat. Premonitary symptoms:—feeling of uneasiness. Onset with shivering, fever and restlessness. Diarrhœa with griping. Slow recovery. *Incubation period—* 18 *hours.*

Case No. 13.—J. N. B., aged 40 years. Took everything including *ice-cream.* Onset with diarrhœa followed by shivering and fever; nausea and griping. Signs of collapse. No vomiting. Very slow recovery. *Incubation period—*18 *hours.*

Case No. 14.—S. M. M., aged 26. T ok everything including *ice-cream.* Onset with diarrhœa attended with severe griping. Shivering; temperature 101° F. Nausea but no vomit ing. Recovery. *Incubation period—*12 *hours.*

Case No. 15.—K. D. R. C., aged 37. Took every thing including *ice-cream*. Onset sudden with diarrhœa. No vomiting, but nausea. Shivering with fever, temperature 102.°4 F. Severe griping; stools greenish, thin, offensive. Recovery. *Incubation period*—20 *hours*.

Case No. 16.—R. T. B., aged 50. Took all foods sparingly. Onset sudden with diarrhœa attended with griping pain. No vomiting. Fever. Stools yellowish, thin with offensive odour. Temperature 101° F. Recovery. *Incubation period*—18 *hours*.

Case No. 17.—K. P. S., aged 29. Took everything including *ice-cream*. Onset sudden with shivering and fever; Temp. 100° F. Griping. No vomiting. Recovery. *Incubation period*—20 *hours*.

Case No. 18.—S. N. M., aged 28. Took everything including a large quantity of *ice-cream*. Premonitary symptoms:—lassitude, loss of appetite. Onset with shivering and fever. Diarrhœa with griping; stools thin and offensive. Recovery in a fortnight. *Incubation period*—45 *hours*.

Case No. 19.—J. N. G., aged 57. Took everything including *ice-cream*. Onset sudden with diarrhœa followed by fever and pain in the stomach. No vomiting. Recovery. *Incubation period*—18 *hours*.

Case No.—20.—S. C. B., aged 20. Took everything including *ice-cream*. Onset sudden with vomiting and diarrhœa, followed by fever

and cramps. Recovery. *Incubation period*—18 *hours.*

Case No. 21.—S. C. G., aged 22. Took everything including *ice-cream.* Onset sudden with fever followed by vomiting and diarrhœa. Recovery. *Incubation period* 22 *hours.*

Case No. 22.—A. T. C., aged 32. Took other foods but not meat, fish or *ice-cream.* Onset with vomiting and diarrhœa followed by fever and cramps. Much prostration. Recovery. *Incubation period*—20 *hours.*

Case No. 23.—H. L. B., aged 31. Took everything including *ice-cream.* Onset sudden with diarrhœa and fever. No vomiting. Recovery. *Incubation period*—18 *hours.*

Case No. 24.—H. C. D. Took everything including *ice-cream.* Onset sudden with vomiting, diarrhœa followed by fever. Recovery. *Incubation period*—20 *hours.*

Case No. 25.—A. C. B. Took everything including *ice-cream.* Onset sudden with vomiting and diarrhœa attended with fever. Recovery. *Incubation period*—20 *hours.*

Case No. 26.—C. L. B., aged 42. Took everything including *ice-cream.* Onset sudden with diarrhœa ; no vomiting ; chilliness followed by fever. Symptoms of collapse. Stools dark-green, frothy, very offensive, consisting of mucus. No nausea or vomiting. Severe griping. Slow recovery. *Incubation period*—15 *hours.*

Case No. 27.—B. K. B., aged 43. Took everything including *ice-cream.* Onset with

diarrhœa; no vomiting, no fever, Diarrhœa slight. Recovery. *Incubation period—2 hours.*

Case No. 28.—S. K. B., aged 18. Took all foods sparingly. Onset sudden with diarrhœa; no vomiting. No fever. Recovery. *Incubation period—2 hours.*

Case No. 29.—S. K. B., aged 18. Took a little of all kinds of food including *ice-cream.* Onset sudden with diarrhœa followed by shivering and fever. Temperature kept 105° F. for three days. No vomiting but had nausea. Delirium, collapse followed by coma and *death* on the 6th day. *Incubation period*—17 *hours.*

Case No. 30.—P. N. B., aged 55. Took all food excepting preparations of meat. Onset sudden with diarrhœa followed by fever attended with severe rigor. No vomiting. Recovery. *Incubation period*—20 *hours.*

Case No. 31.—K. M. K., aged 48. Took all kinds of food except *polao* and *ice-cream.* Onset sudden with fever attended with rigor followed by diarrhœa; stools thin, dark-green containing shreds of mucus. Profuse cold sweats attended with much prostration. No vomiting, no nausea; griping. Recovery slow. *Incubation period*—21 *hours.*

Case No. 32.—A. L. B., aged 45. Took food very sparingly with a little *ice-cream.* Onset sudden with fever followed by diarrhœa. Much prostration and depression of pulse. Conjunctivæ slightly icteric. Recovery. *Incubation period*—20 *hours.*

Case No. 33.—J. K. B., aged 43. Took only a little meat curry and a little *ice-cream*. Onset sudden with fever attended with distressing nausea and diarrhœa. Griping. Slight vomiting. Slow recovery. *Incubation period*—40 *hours*.

Case No. 34.—B. L. D., aged 42. Took *ice-cream* and a few sweets only. Premonitary symptoms:—pain in the stomach. Diarrhœa with much pain in the abdomen. No vomiting. Fever and weakness. Recovery. *Incubation period* 18 *hours*.

Case No. 35.—P. C. C., aged 22. Took all kinds of food including a large cupful of *ice-cream*. Premonitary symptoms:—general uneasiness, sensation of heat all over the body; griping. Onset with diarrhœa followed by fever; highest temp. 103° F. Stools watery, dark-green, containing shreds of mucus and very offensive. Restlessness, profuse sweating, delirium and collapse. No vomiting or nausea. He became cyanosed before *death* which took place on the 5th day. *Incubation period*—8 *hours*.

Case No. 36.—S. C. H., aged 25. Took all foods including *ice-cream*. Premonitary symptoms:—griping and slight looseness of bowels. Fever, with shivering followed by diarrhœa. Temp. 104° F. Vomiting. Much prostration. Recovery slow. *Incubation period*—23 *hours*.

Summary of the Symtoms.—It will be seen from a perusal of the above cases that there was a distinct period of incubation

in almost all of them. The period varied, however, in different cases. In 26 out of the 35 cases, the incubation period ranged from 12 to 24 hours; in 6, it was 12 hours or less; in one case, it was 33 hours, and in 2 cases, it was 40 and 45 hours respectively. Of the 4 fatal cases, the symptoms in one began in 8 hours, in another in 14 hours and in the remaining 2 cases in 17 hours. The period of incubation does not appear to bear any relation to the virulence of the attack, but it may be observed that the cases in which the incubation period varied from 12 to 24 hours, were generally of a severe type. On the other hand, cases in which the symptoms appeared very shortly after taking the meal as well as those that were prolonged beyond 24 hours, generally suffered less and recovered quickly. It is possible that the diarrhœa and vomiting in the early cases helped the rapid elimination of the infecting agent from the system and thus prevented a severe manifestation of the disease. In the later cases, it is possible that the soil was not quite favourable for the rapid growth of the infecting element.

In 27 cases, the onset was sudden and unexpected; 20 cases commenced with diarrhœa and 7 with fever. In 9 cases, 2 of which proved fatal, there were observed certain premonitary symptoms, such as uneasiness, heaviness in stomach, loss of appetite, headache, griping pain in the bowels and slight diarrhœa. In 34 out

of 36 cases, there was fever in the course of the illness which commenced invariably with shivering. In the fatal cases, the fever was not only very high but its duration was also prolonged. Diarrhœa, of more or less violence, was present in all the cases; the stools were thin and generally profuse in quantity, of a greenish-yellow or dark-greenish colour, largely mixed with shreds of mucus and in a few cases, particles of undigested food were noticed in them. They were as a rule very offensive. Diarrhœa in most cases was accompanied with a griping pain usually of a severe character, which in a few cases persisted even after the disappearance of the other symptoms. In no case, blood had been noticed in the stools. Vomiting more or less severe was present in 15 cases only and it is worth mentioning that it was absent in 2 of the 4 fatal cases, and in the other 2, it was in a very mild form. One of the most marked symptoms in all the cases without exception was great prostration with muscular weakness which continued for several days after recovery. Thirst where present was intense and distressing. In some of the fatal cases when the skin was cold, the temperature under the tongue was high. The tongue in some cases was found to be coated with a brown fur and its edges and tip were red. Delirium was present in the fatal cases only, and it intervened a few hours before death. In one of the fatal cases, coma supervened early; in two, it appeared only a few hours before

death, and in the remaining case, consciousness was perfect up to the last moment. Slight yellowness of the conjunctivæ was noticed in one case only. In a few cases, cramps of the extremeties were present. No convulsion was noticed in any of the cases. Sleeplessness was a marked symptom in some of the cases. Cardiac weakness was present in almost all cases.

Diagnosis.—The simultaneous occurrence of such a large number of cases exhibiting almost exactly similar symptoms had led to a strong suspicion of there being some fault in the food taken on Saturday; but as regards its exact nature, there was a considerable difference of opinion. One eminent physician, thinking that he had detected a blue line in the gum of one or two of his patients, ascribed the symptoms to lead-poisoning, derived from the ice-cream pots. Another thought it was copper-poisoning caused by food cooked in imperfectly tinned copper-pots. Most medical men, however, suspected poisoning by ptomaines, generated in the meat, or the fish, or the condensed milk supposed to have been used for the ice-cream.

Let us examine these views one by one.

Lead.—As regards lead, a blue line in the gum, though a constant sign of chronic cases of lead-poisoning, is never found in acute cases. Constipation, and not diarrhœa which was present in all the cases under consideration, is the rule in lead-poisoning. Further, the

nervous symptoms of lead-poisoning, such as convulsions and paralysis, were absent in these cases. Lead, therefore, can safely be excluded.

COPPER.—There is a popular, though erroneous, belief, shared by many medical men, that food cooked in untinned or imperfectly tinned copper-pots, is a fruitful source of copper-poisoning. Without denying that certain articles of food might absorb a small quantity of copper when cooked in such copper-pots, I maintain that the quantity thus absorbed would not be sufficient to produce the violent symptoms observed in these cases. I am inclined to doubt the possibility of acute copper-poisoning from this source, except under very exceptional circumstances, such as the boiling of the food-articles with strong vinegar or other acids in copper-vessels. In almost every Hindu kitchen in the country and in the Indian army, all sorts of food are daily cooked with a free use of ghee and salt in pots made of brass which is of course only an alloy of copper and zinc. We rarely meet with cases of copper-poisoning amongst these people. In Calcutta, many Mahomedan sweetmeat-sellers of Fouzdari-Balakhana daily prepare large quantities of their commodities containing large proportions of ghee, salt and sugar in *untinned* copper-pots. Their sweetmeats have several times been examined in the Health Officer's Department with a view to detect copper, but the results have always been negative.

Blythe (*Poisons, their Effects and Detection*, P. 612) says :—"It is pretty well accepted that cooking in clean bright copper-vessels will not contaminate any ordinary food-stuff sufficiently to be injurious to health."

Taylor (*Medical Jurisprudence*) observes :—"If the copper vessel used is perfectly clean and the food prepared in it is allowed to cool in other vessels, there is not much risk of its acquiring a poisonous impregnation."

Dixon Mann (*Forensic Medicine and Toxicology*, pp. 484, 485) says :—"According to the popular idea, copper in the smallest doses is a virulent poison ; the least contamination of the food with the dreaded verdigris is regarded as pre-eminently dangerous. Formerly toxicologists shared these views and never questioned the existence of chronic copper-poisoning ; modern authorities on the other hand, with few exceptions, state *that it is unknown.* * * * * * * Cases of acute irritant poisoning, which are reported from time to time as being due to food which has been cooked or stored in copper-vessels, are *probably almost invariably* instances of toxin-poisoning from decomposition-products present in the food. The amount of copper needful to produce the violent symptoms of poisoning described in such cases is much greater than could possibly be present, if indeed any amount of copper could cause symptoms comparable with those of a virulent toxin."

The following extract from Blythe's book (p. 612) will show that even when copper is present in all the dishes of a meal short of giving a metallic taste to them, the total dose is not sufficient to produce the violent symptoms like those observed in the present outbreak or in other recorded food-poisoning cases attributed to copper :—"Lehmann discusses the amount of copper, which may be taken at a meal under the circumstance that every thing eaten or drunk has been artificially "coppered," but none coppered to the extent by which the presence of the metal could be betrayed by taste; and the following is he thinks, possible :—

300 c.c. of soup boiled in a copper vessel	20 m.g. of copper.
1 litre of wine which has been already standing in a copper vessel	50 m.g. ,,
50 c.c. of vinegar which has been kept in a copper vessel	10 m.g. ,,
50 grams of fat which has been used for frying in a copper vessel	5 m.g. ,,
200 grams of strongly coppered peas	50 m.g. ,,
500 grams of strongly coppered bread	60 m.g. ,,
Total	195 m.g. of copper.

"The total only amounts to 195 milligrams of copper (or 3 grains) which only slightly exceeds a high medicinal dose."

With reference to peas coloured by copper-salts, Prof. Glaister of Glasgow says:—"The sulphate (of copper) is used for the purpose of giving an artficial colour to preserve vegetables, such as peas and others. 'From a *personal and family use* of such preserved peas over continuous lengthy periods, we have not discovered any unusual symptoms." (*Medical Jurisprudence, Toxicology and Public Health*).

Acute copper-poisoning by the ingestion of food cooked in copper-vessels is of rare occurrence in this country. I have looked into the records of the Bengal Chemical Examiner's Office as far back as 1880 and I have not found a single case. The Chemical Examiner of Bombay has recorded in his Annual Report for 1891 a case as that of copper-poisoning; but from the short account given below, it would appear that his conclusion was not justifiable. About 150 persons were present in a feast, 100 of whom became ill suffering from diarrhœa and vomiting, and ten died. The brass cooking pots, as well as samples of the food were forwarded to the Chemical Examiner, Bombay, for examination. He detected copper in the contents and washings of the brass vessels, "but no copper was detected in the samples of food or in any other article sent." The Chemical Examiner stated that the source of copper was

most probably the brass-pots having been imperfectly cleaned. It is no wonder that copper should be detected in the remnants of food kept for sometime in brass-pots before they were examined. But this fact alone, especially in the absence of copper in the food, would not justify the conclusion that copper caused the poisoning. The Assistant Chemical Examiner of Bombay informs me that during the past twelve years, he has not come across a single case where a number of persons were poisoned by copper by the ingestion of food cooked in copper-pots.

PTOMAINES:—As regards ptomaine poisoning, though some of the cases such as Nos. 8, 27 and 28, with remarkably short incubation-periods, would suggest poisoning by a ready-formed irritant matter, yet such a supposition could not for obvious reasons apply to the majority of the cases, in almost all of which the incubation-period was very much prolonged.

BACTERIA.—I believe, therefore, that the real cause was an agent that was practically innocuous at the time of its entrance into the stomach, but afterwards finding suitable conditions for its growth and multiplication, developed a toxin which produced the poisoning symptoms. Such an agent can only be found in some form of bacteria.

This view is supported by the results of investigation of a large number of recorded cases of food-poisoning. Ballard records two remarkable instances of poisoning by ham and

unbaked pork. The first occurred at Wellback in 1880 and the second at Nottingham in 1881. In the Wellback case, the period of incubation varied from 12 hours or less to more than 48 hours in 51 cases. In many of these cases, the first definite symptoms occurred suddenly but premonitary symptoms were also found in some of them. The symptoms were pain in the abdomen, diarrhœa, vomiting (the diarrhœa being of more constant occurrence than the vomiting), shivering, fever, extreme muscular weakness and cardiac exhaustion. The stools were extremely offensive and of a dark colour. Temperature rose in certain cases to 101°F., 103°F. or 104°F. In three cases, yellowness of the skin was noticed. In nearly all the cases, debility was very marked and continued for several weeks during convalsecence (*Osler: Principles and Practice of Medicine p.* 391). Klein examined the meat and found it loaded with bacilli which were also found in the organs of the fatal cases.

Of the three outbreaks of epidemic diarrhœa which occurred at St. Bartholomew's Hospital, London, (the first in 1895, the second in 1897 and the third in 1898), the first two were due to the consumption of particular samples of milk and the third to the eating of some rice-pudding prepared from a certain sample of milk. The symptoms, on each occasion, very closely resembled those recorded in the Wellback cases. In the second epidemic, the milk had been taken

between 8 and 10 a.m., and the disease manifested itself from between 8 p.m. and 4 a.m. next morning (incubation-period being from 12 to 20 hours). In the incriminating milk and in the stools, the presence of numerous spores of the *bacillus enteritides sporogenes* was detected by Klein.

In the third epidemic in August 1898, symptoms similar to the two previous outbreaks followed the eating of a rice-pudding made with infected milk. Dr. Andrews demonstrated the abundant presence of the spores of *bacillus enteritides sporogenes* in the rice-pudding itself as well as in the fluid bowel-discharges of the patients.

In the outbreak of food-poisoning at Chadderton in July 1898, about 47 persons were attacked with symptoms similar to those observed in the Wellback food-poisoning case by eating some veal-pie. Four of the cases proved fatal. The result of the investigation showed that the poison was contained in the veal and jelly; and that it consisted partly of ptomaines and partly of bacteria. As the incubation-period was short in this outbreak (from 5 to 8 hours), it was thought that the greater part of the symptoms were due to ptomaines (see *British Medical Journal*, Nov. 5, 1898, p. 1456).

Osler states that "various milk-products, ice-cream, custard and cheese may prove highly poisonous. In an extensive ice-cream epidemic. Vaughan and Perkins found in the ice-cream a

highly pathogenic bacillus, but its toxin had not been separated. The symptoms were those of acute gastro-intestinal irritation and were similar to those already detailed by Ballard."

The Bhowanipore food-poisoning case very closely resembles the cases just cited and many others investigated by competent authorities in recent years. And as the poisoning in the previous instances has been traced to infection of food by certain pathogenic bacteria, the same factor may be held to have operated in the present case also. In regard to the identity of the bacteria in the present outbreak, the history of the cases and the character of the symptoms would distinctly point to infection by *Bacillus Enteritides Sporogenes* to which Drs. Klein and Andrews ascribed the three successive outbreaks of epidemic disarrhœa at St. Bartholomew's Hospital. In the absence of a bacteriological examination, it would be hazardous to advance a more definite opinion, which, in the present instance, can be based on analogy only.

INFECTED FOOD.—I shall now endeavour to fix upon, if possible, the particular food which was responsible for the unhappy results. In the absence of a bacteriological examination, I can base my conclusions only on such evidence as is before me. Of the 36 cases, 32 or about 91.4 per cent. took all kinds of food including *ice-cream*. There are several authentic cases *in which the only food taken was the ice-cream*;

the symptoms in these cases were exactly similar to those observed in others in which all kinds of food including *ice-cream* were taken. Dr. Cook in his first report states "that four guests, who said that they ate *ice-cream only* were attacked, and three female servants, who ate *ice-cream* (mixed with rice) were also attacked. * * * On the other hand, the servants who prepared the ice-cream state that they ate none of it themselves, but ate only sweet-meats and they were attacked and one or two of the guests give similar evidence. I conclude from this that both the *ice-cream* and the sweet-meats were the causes of the attacks." I shall try to show that the *ice-cream* was the primary cause and that other articles of food, which were supposed to have produced similar symptoms in a few cases, were only secondarily responsible. If instances could be cited in the first batch in which the ingestion of every article of food except *ice-cream* was not followed by toxic symptoms, the suspicion against such food-articles might be reasonably discarded. Six persons of the same family went to the dinner; four of them took all kinds of food except *ice-cream* but the remaining two took these and *ice-cream* as well. The former escaped the attack altogether but the latter two had it in a severe form. Out of a batch of nine gentlemen who sat together to dine, eight took everything including *ice-cream* and suffered a good deal, whereas the ninth left out the *ice-cream* and

escaped unharmed. Among many others, several of my personal friends did not take any *ice-cream* and escaped. No fault could be attached to the meat or the fish, as in none of the cases, the consumption of these articles alone was attended with poisoning symptoms. No suspicion can also be attached to the sweetmeats, curd, rabri, &c., as in several instances, only these were taken with no untoward results. Dr. Jogendranath Ghosh informs me of seven cases amongst many others who took nothing but sweetmeats, dahi and rabri and did not suffer at all.

The explanation to cases Nos. 22 & 31, where toxic symptoms were manifested though no *ice-cream* had been taken, lies in the possibility of the accidental contamination of some of the other articles of food with the infected *ice-cream*, through the carelessness of the distributors. Where such a large number of people are entertained, it almost always happens that one kind of food comes in contact with another on account of the same hand or spoon used for distribution not being carefully washed before each serving, especially towards the end of the dinner. Moreover, the occurrence of so few cases of poisoning of this kind without the consumption of the *ice-cream* would suggest the accidental contamination of a small quantity of some other article of food by the infected *ice-cream*.

Dr. Cook has stated that some persons who had taken *ice-cream* had shewn no symptoms of poisoning. I must say that the absence of details about such cases engenders a sense of doubt as to their authenticity. But even if such cases did happen, they may easily be explained by well-established facts about bacterial infection, such as powers of resistance, unequal distribution of the bacteria in the infected substance and the dose. It might be that these persons had strong powers of resistance, or that the bacteria were unequally distributed in the *ice-cream*, or even that some pails of the *ice-cream* had escaped infection altogether, or that the quantity of *ice-cream* taken by these people was very small.

The above facts certainly justify the conclusion that it was the *ice-cream* which was primarily infected.

Source of Infection.—How was the *ice-cream* infected? Dr. Cook says—"there was every possibility of the food being infected with sewage-bacteria in either of two ways:—(1) the unglazed earthenware vessels in which food was eaten were washed in a very foul tank in the compound; or (2) several of the dishes were kept for some hours on the brick-floor of a cow-shed with a current of air passing over them from the tank referred to and a heavy fall of rain shortly before, which thoroughly stirred up the stagnant water of the tank." Dr. Cook further asserts "that the heavy rains of Saturday morn-

ing caused *displacement of subsoil-air containing bacteria* to which the food remained exposed in the cow-shed for some hours and got infected."

I admit that the use of the water of the foul tank for any purpose whatsoever, the more so for rinsing the earthenware vessels used for serving food to the guests, and the storing of the food-articles in the cow-shed, were most objectionable; but I cannot admit that these facts were responsible for the results.

The splashing of a tank by heavy rains might cause the bacteria present in it to be carried to the air with minute particles of water, but this can only happen while it is still raining. The rains on Saturday had ceased altogether at about 10 a.m. No food for Saturday's dinner was prepared and stored in the cow-shed before 2 p.m. As there was then and afterwards no rain, there was, therefore, no possibility of any bacteria being carried by the air over the food by the splashing of the tank.

As regards the *displacement of the subsoil air* by rain-water, it would certainly not cause the bacteria present therein to be carried up by such air. Such a theory can scarcely hold its ground against all modern knowledge of infection of air by bacteria. Air by itself is wonderfully free from these organisms. It is the *dust* which carry bacteria and by its suspension in the air renders it infections. Dr. Allan Macfadyan, Director of the Jenner Institute of Preventive Medicine, in the course of a lecture

delivered at the Royal Institute on "*The Effects of Physical Agents on Bacterial Life*", made the following observation:—"A shower of rain purifies the air greatly of bacteria. Bacteria cannot pass independently to the air; they are forcibly *transferred to it with dust* from various surfaces. The relative bacterial purity of the atmosphere is mainly, therefore, a question of dust. * * * The *majority of bacteria pass in the air not from moist, but from dry surfaces.*" It is hardly necessary to quote more opinions on this point.

It will thus be seen that there was very little chance of bacteria being carried into the cow-shed, either by the displacement of ground-air or by the splashing of the tank when the rain had ceased, and infect the food placed therein. The rain of Saturday morning not only purified the air of bacteria but by keeping the ground moist and free from dust, practically prevented dissemination of bacteria present in the soil.

Leaving aside the question of the infection of other articles of food, which, as I have shown, were not primarily affected, let us now see if the *ice-cream* could have been infected in the way suggested by Dr. Cook. As a matter of fact, the *ice-cream* was not ready till near the end of dinner of the first batch. This is why many guests fortunately had no occasion to take it. It was prepared near the stable, at the spot marked by a black dot in the plan, at a distance

from the tank; there was no time for storing it in the cowshed (at least the first few pails which were mainly responsible for the disaster); and as it was prepared in covered pots, it could not have been exposed to the effluvia from the tank even for a short time in the manner suggested by Dr. Cook.

The fact of Dr. Cook's finding some indefinite colon bacilli in one of the foulest tanks in Bhowanipore does not help to establish its connection with the infection of the *ice-cream.* We must look somewhere else for the source of the infection.

My belief is that the milk with which the *ice-cream* was prepared, had been infected. It was brought to the house infected or became so there. My first information was that the contract for the supply of *ice-cream* was given to some one in the Municipal Market. It was suspected that the contractor had used tinned milk of a questionable quality for the preparation of the *ice-cream.* If this were true, one need not go far to seek for the manner of infection of the *ice-cream.* On further enquiry, however, I find that the contract was for labour only, the materials having been supplied by the host. Fifteen seers of milk were got for this purpose from a milk-vendor of Bowbazar; this was concentrated in the house over a slow fire, mixed with sugar and mango-pulp and then taken to the place near the stables, worked up with eggs, flavoured with some essence of vanilla,

and made into ice-cream. The machine was worked by the contractor's men helped by some of the grooms of the host. The ice-cream was prepared at different sittings.

The moulds were examined by Dr. Cook a few days after the feast and were found to be in a fairly good condition; but this examination not having been made either before or immediately after their use is of questionable value.

It may be said that if there were bacteria in the milk, they should have been killed during the process of concentrating the milk. Now, *non-spore-forming* bacteria certainly would have been killed as they could not stand a temperature of 80°C. for a short time, but not so the *spore-forming* ones—one variety of which, as I shall endeavour to show, was probably the cause of infection in this particular instance. Milk is usually concentrated over a slow fire, the temperature being kept many degrees below the boiling point. The spores of the anærobic bacillus enteritidis sporogenes could resist a temperature higher than 100°C. According to Dr. Klein, "they withstand perfectly unharmed a temperature of 100°C. for several minutes, one of 98°C. for a considerable time. Thus Dr. Wild, who worked in my laboratory in 1898, found that in some instances, the spores of bacillus enteritidis (from sewage), were capable of withstanding unharmed, boiling (100°C.) for as long as 15 to 30 minutes" (*Local Government Board Report, Supplement*, 1898-99).

If, therefore, these spores were present in the milk used for the *ice-cream*, they could not have been killed during the process of concentrating it, *as practically at no stage of the process, could the temperature of the milk have risen to 100°C.*

It may, therefore, be concluded that if the milk was infected before it had reached the house of the host, it remained so till it was consumed by the guests in the form of *ice-cream.* The spores remained dormant in the *ice-cream* at the low temperature, and finding suitable conditions in the intestinal canals of those that had taken it, grew and multiplied there and gave rise to symptoms of acute gastro-enteritis. It is possible that some amount of toxin had been produced by the bacteria while in the milk or ice-cream before this was consumed. These circumstances would explain the occurrence of the few cases already noted with very short incubation-periods.

Another possible source of infection of the *ice-cream* might be traced to the soil of the very place in which it was prepared. Bacillus enteritidis sporogenes is very widely distributed in nature, *the stable being one of its favourite abodes.* Besides being found in sewage of all descriptions, its spores have been demonstrated in *the dung of horses and in all substances polluted with it,* for example, sweepings of the street, garden-earth, earth from manured meadows and fields &c. Dr. Klein asserts that every sample of

manured earth yielded positive evidence of the presence of the bacillus itself (*Local Government Board Report*, *Supplement*, 1897-98 p. 238).

The preparation of the *ice-cream* in a place saturated with the dung of horses like the ground of the stables, afforded ample opportunities to the spores of the bacillus enteritidis sporogenes to obtain access to the milk and infect it and the *ice-cream* prepared from it. Moreover, the machine was worked for sometime by grooms who are not reputed to be very cleanly in their habits and from whose hands, a weighable quantity of horse-dung can always be scraped out. It is highly possible that the milk, even it had not been infected before, became so when being made into ice-cream, by the stable boys on the grounds of the stable.

I must mention here that according to Dr. Klein, it is a noteworthy fact that the presence of the bacillus enteritidis sporogenes has *never been detected in cow-dung*. The storage of the food-articles in the cow-shed would not, therefore, likely lead to their infection by these bacilli.

In conclusion, I have to thank Dr. Hira Lal Sinha, B.A., L.M.S., for the help I have received from him in the preparation of this paper.

Poisoning By Sulpho-cyanide of Mercury.*

Only one case of poisoning by *Sulpho-cyanide of Mercury* in a human subject is on record. In this case which occurred in 1865, a *Pharoah's Serpent* was swallowed by an adult male who in consequence suffered from pain, dyspnœa, vomiting and rigors but ultimately recovered. Blythe records an experiment in which .5 gram (about $7\frac{1}{2}$ grains) of the poison administered to a pigeon killed the bird in 40 hours "without convulsions". The bird was "indisposed" but no other symptoms were noted. So little is known of the action of the poison on human organism that the following case which came under my observation in November 1904, is worth recording.

T., a sickly Hindu female child, aged 14 months, took a piece of the toy called "Pharaoh's Serpent" on the 7th November, 1904, at 7 a.m. It was kept in a small basket with other fireworks on the previous night which was the *Dewali* night. The contents of the basket were

* Indian Medical Gazette, March, 1905.

removed on the next morning and some parched rice was given to the child in the same basket. Unfortunately, one piece of the toy remained in the basket undetected and this the child took with the parched rice. The child experienced a disagreeable taste which found expression in her face and which attracted the attention of the attendant who put his finger into her mouth and brought out a small quantity of a yellow sulphur-like stuff which was at once recognised to be a portion of the toy.

Shortly after, she began to vomit attended with severe retching. The matter first brought up consisted of frothy mucus mixed with the pale yellow substance she had taken. She vomitted several times within half an hour when she was removed to a neighbouring dispensary where she was given two doses of sulphate of zinc (15 grains each) followed by warm water drink. This brought on copious vomiting. The vomited matter was of a yellowish colour mixed with much mucus. At about 8 a.m.. the child was brought to me. She was weak and sleepy, apparently from exhaustion : otherwise she was not bad. I advised small quantities of a mixture of milk and eggs to be given to her at frequent intervals, with 15 drops of brandy. The child brought up the first two doses of the egg mixture, but after that there was no more vomiting. The child remained sleepy and prostrated for about 3 hours and then began gradually to recover. The bowels were not moved and she

made water for the first time at 3 p.m. after the ingestion of the poison and then freely again at about 5-30 p.m. She had fever in the evening (temperature 101°F.) which kept on during the night. There was no more vomiting and no purging. She slept well during the night and was found all right next morning. As in the case of poisoning by other salts of Mercury, the symptoms were of an irritant nature.

"Pharaoh's Serpent" is a toy prepared by mixing a compound of mercury, called sulpho-cyanide of mercury [$Hg(CNS)_2$], with gum and made into small cylinders. I examined one of the pieces brought to me by the father of the child; it was of a pale yellow colour (like sulphur), cylindrical in shape, $\frac{1}{4}$ inch in length, and about $\frac{1}{8}$ inch in thickness. It weighed .225 gramme ($3\frac{1}{2}$ grains).

I submitted the piece to chemical analysis and detected *mercury* and *sulpho-cyanic acid* in it.

When burnt, it kindled and swelled up as usual to a bulky snake-like mass.

A Case of Formalin Poisoning.*

Cases of poisoning by Formalin are not at all common. Professor Glaister of Glasgow in his book of Medical Jurisprudence mentions two cases only in which, however, the symptoms did not agree. In one of the cases recorded by Kluber, the symptoms were of a purely narcotic character; in the other case recorded by Zoru, they were of an irritant nature. Both these cases were non-fatal.

A case which occurred in Calcutta in April, 1904, showed irritant symptoms only, and so far, closely resembled the second case of Prof. Glaister. I record the case below:—

HISTORY.—W. T., Eurasian male, aged about 47 years, had been drinking hard for some weeks. He was hopelessly drunk on the 28th April; about half past four in the afternoon, he swallowed by mistake about 3 ounces of a 40% solution of Formalin which had been purchased for some photographic operations. Almost immediately after, he was found by his son groaning with his right hand over his stomach and was unable to speak. When he was able to speak, he complained of a burning sensation in

* Indian Medical Gazette, April, 1905.

the throat and stomach and pointed to the Formalin bottle, the contents of which, he said, he had swallowed by mistake. He was removed to the Medical College Hospital at 5-30 p.m. He did not vomit before admission into the Hospital.

SYMPTOMS.—On admission, his pulse was rapid, 140 per minute ; his face was flushed ; his pupils were equal but rather contracted. He was perfectly conscious and answered questions rationally.

His stomach was washed with warm water and the washings were preserved for analysis.

Shortly after admission, he began to vomit and there was continued vomiting during the night. The vomited matter at first consisted of a thin sanguinous fluid, but later on, there was a good deal of dark-coloured blood and mucus in it. The pulse gradually became feebler and early on the following morning, it became almost imperceptible. The patient gradually sank and died at about 10-30 a.m., on the following day (about 18 hours after the ingestion of the poison). The patient retained perfect consciousness up to the last moment and developed no nervous symptoms.

TREATMENT.—He was treated with hypodermic injections of morphine and afterwards of strychnine.

POST-MORTEM SIGNS..—The *post-mortem* examination was held by the Police Surgeon of Calcutta, on the 30th April at 7-15 a.m. The mucous membrane of the stomach was

found intensely congested; there were erosions and extravasations of blood in the stomach. The stomach contained about half an ounce of blood; there was no perforation.

The small and large intestines were congested. The liver was pale-yellow and fatty; the lungs and the membranes of the brain were congested. The right cavity of the heart contained a little fluid blood and some clots; the left cavity also contained some blood.

CHEMICAL ANALYSIS.—The stomach, its contents and some portions of other viscera, preserved in salt solution, were sent to me for analysis. I could detect neither *formalin* nor *alcohol* in them.

The stomach washings preserved in the Hospital, were also examined by me. They were distilled and in the distillate, I detected both *alcohol* and *formalin* in marked quantity.

REMARKS.—The prominent symptoms in this case were the burning sensation in the throat and stomach and the incessant vomiting of bloody fluid. These, as well as the *post-mortem* signs, would point to Formalin being a strong irritant poison. The retention of consciousness throughout the attack and the absence of all nervous symptoms seem to indicate that it possesses no narcotic properties, but the nature of the symptoms recorded by Kluber is against such a theory. In Kluber's case, the man took several ounces of commercial Formalin, He grew drowsy and passed into a comatose

condition which continued for several hours. His skin was cold and pale and his respirations were frequent; there was no paralysis. There was a complete absence of all irritant symptoms but the mucous membrane of the mouth and soft palate were found red and inflamed. The comatose condition was succeeded by one of cerebral excitement and confusion. There was suppression of urine for several hours. Recovery took place within three days.

In the second case recorded by Zoru, the patient took 15 c.c. (½ ounce of Formalin), had violent retching and vomiting shortly after swallowing the poison; he complained of a buring pain in the mouth and stomach, but he never lost consciousness. This case also ended in recovery.

The present case is perhaps the only case on record having had a fatal termination; it thus afforded an opportunity for the study of the action of the poison on the internal organs.

It seems probable that Formalin is both narcotic and irritant and that the nature of the symptoms varies according to the dose administered.

As Formalin is rapidly coming into large use in the various branches of Science and Industry, it is likely that cases of poisoning by it would crop up more frequently and its true character will soon be decided.

Suicide by Inhalation of Chloroform.*

The title of the paper may suggest the question:—"Is it possible for a person to commit suicide by inhalation of Chloroform?". The violent struggles, usually seen when a person is being put under chloroform, would tend to throw some doubt on the capability of a person continuing the administration of chloroform on himself during the stage of excitement. And even admitting that such strength of purpose and patience are possible in a determined suicide, one would hardly expect to see a fatal termination in such cases, from the simple fact that all further administration of chloroform must cease as soon as the patient becomes insensible; and judging from what happens every day in our surgical practice, the patient ought to recover rapidly from the effects of the drug as soon as it is discontinued.

I answer the above question in the affirmative. Although about 99 per cent. of death by chloroform are due to accidents occurring during the administration of the drug as an anæsthetic, cases of suicide by chloroform, though their

* Calcutta Medical Journal, January, 1907.

number is small, do occasionally occur, and, among these, a few authentic cases are on record in which chloroform was used in the form of inhalation. It would not be difficult to believe in the occurrence of such cases when we remember that altogether different conditions prevail in the administration of chloroform in the two kinds of cases under discussion. In surgical operations, we give chloroform *largely diluted with air*, the safety-limit now adopted being 2 to 3 per cent. of chloroform in the air. Then we take all necessary precautions to satisfy ourselves that the patient is a fit subject for chloroform inhalation and we also carefully watch the onset of any untoward symptoms. When inhaled in such diluted form, insensibility is produced slowly, usually preceded by a stage of excitement. But chloroform, although so safe when administered in a diluted form, "*speedily proves fatal to life when inhaled in a concentrated form*". And this factor, absent in our surgical cases, is prominently present in cases of suicide by inhalation of chloroform. Here the person uses it not only in large quantities but in a manner which excludes the chance of its being diluted with air and hence in a concentrated form. Death in such cases in all probability, rapidly supervenes before the onset of the stage of excitement.

In the present case, chloroform was not only inhaled in a concentrated form but its inhalation was continuous, as it was found

dribbling on the handerkchief even when life was extinct.

Then there are other factors which might bring on a speedy fatal termination; *idiosyncracy* is one of them. There are two cases on record, in one of which death took place in two minutes, only 30 drops of chloroform having been administered; and in the other case, inhalation of 20 drops only was followed by death in one minute: in both these cases, the drug was used as an anæsthetic. Death in these two cases could be ascribed to idiosyncracy only. Then again, the existence of a *fatty* or *flabby heart* is another factor which to some extent influences the speedy fatal termination in such cases.

Without making any further preliminary observations, I would give you a short history of the case:—

History.— Mrs. H., a Eurasian woman, aged about 26 years, was found dead in her bed at 11-30 p.m., on the 8th March, 1906. The door of the room was barred from inside. She was lying on her left side *with a pillow over her face and a handkerchief over her mouth and nose.* An ordinary screw-topped Eau-de-Cologne bottle containing about half an ounce of chloroform was lying near the handkerchief and chloroform was found dribbling from it on the handkerchief. The husband, in his evidence before the Coroner of Calcutta, stated that the deceased wanted him that evening to accompany her to the New Market which he refused, saying that

he was going to the Rink and asked her to accompany him there which she would not. She went out at about 8-30 p.m., and returned within half-an-hour. About 5 minutes after her return, the husband left the house for the Rink. He returned at about 11-30 p.m. when he found the door of the room barred from inside. On opening the door, he found his wife in the condition described above. He thought she was dead. He sent for a medical man who, on arrival at the house, pronounced her dead. The same medical man attended the deceased 6 months before her death, when she was suffering from symptoms of chloroform poisoning. She was then half-conscious and when brought round told the doctor that she had taken chloroform for a pain in the head. The husband stated in his evidence that the deceased used to suffer from a pain in her back which caused mental depression. No chloroform was kept in the house and the husband could not say how his wife obtained it.

Post-mortem Signs.—I am indebted for the following post-mortem notes to Major J. C. Vaughan, I.M.S., late Police Surgeon of Calcutta, who made the autopsy about 15 hours after death.

The body was fresh and well-nourished, *rigor mortis* marked every where. The pupils were dilated.

There were a few small areas where the skin had the appearance of having been blistered;

these were on the upper lip and about the inside of the nostrils and might have been due to the blistering effect of chloroform. Similar marks were also found over the left cheek.

The blood had, on first exposure, a somewhat cherry-red color which rapidly darkened. It was fluid. No distinct smell of chloroform was detected in it.

There was hyperæmia of the brain; the liver, spleen, lungs and kidneys were also hyperæmic. Œdema of the piamater was noticed.

The heart was healthy; both the right and left cavities were moderately full. There were about 3 drachms of clear serum in the pericardial cavity.

The mucous membrane of the pharynx, œsophagus, larynx, trachæa and bronchii was normal. *There were no blistering marks in the mouth, pharynx or gullet.*

The stomach and intestines were normal. The mucous membrane of the stomach was of a grey color. The stomach contained about 9 ounces of a grey soupy fluid; no smell of chloroform was detected in the contents of the stomach. The bladder was empty.

Chemical analysis:—The stomach, its contents, a piece of intestines and portions of liver, lungs, spleen and kidney with some bloody fluid, were placed together in jars and sent for analysis. On distillation, traces of chloroform were detected in the contents of the jars.

A quantity of dark-colored blood was also sent for examination in a separate phial. The blood had a distinct sweet odour; on distillation, it yielded chloroform.

The glass-phial, which was found near the deceased, contained half an ounce of pure chloroform.

Verdict.—Major Vaughan was of opinion, from post-mortem signs and the results of chemical analysis, that *death was caused by heart-failure due to inhalation of chloroform, self-administered.* The verdict of the jury accordingly was "death by chloroform poisoning, self-administered."

Conclusion.—The absence of local marks in the digestive canal, the presence of blistering marks on the lips, cheek and inside the nostrils, the position and condition of the chloroform-bottle and of the handkerchief and pillow on the mouth and nose of the deceased, the fact of the room having been found closed from inside, the cherry-red colour and the fluid condition of the blood, and the detection of chloroform in it by chemical analysis would leave no doubt as to the case being one of suicide by inhalation of chloroform.

This is probably the first case of suicide by inhalation of chloroform on record in this country and that is my justification in bringing it before you.

This case presents another interesting point for consideration, *viz.*, that the death as revealed

by the autopsy was due to heart-failure, which does not agree with the finding of the Hyderabad Chloroform Commission. It must, however, be admitted that this point has not been finally settled and that opinion is still divided in regard to the mode of death by chloroform poisoning. McWilliams from his experiments infers that chloroform has a direct influence on the heart, *that death occurs from cardiac failure*, and that the respiration may be continued even when the heart has stopped. A case of death from *heart-failure* following the use of choloroform as an anæsthetic, lately occurred in the Nottingham General Hospital and is recorded in the British Medical Journal of the 10th November, 1906.

Some Points of Medico-legal Interest in the Radhabazar Murder Case.*

A murder, under peculiar circumstances, took place in the town of Calcutta in February, 1906, which still remains undetected. It was known at the time as the "Radhabazar murder case" and it possesses some points of medico-legal interest which would justify its publication. The facts of the case have been compiled from the reports of the trial at the Calcutta High Court, as published in the daily papers.

History:—In the early morning of 12th February, 1906, a policeman, while going on rounds in the Radhabazar Lane, found a sack lying on a ledge in front of a doorway. On opening the sack, it was found to contain the body of a Mahomedan male with a gaping wound in the throat. The deceased had a *dhoti* and *kurta* on him and his hands and feet were tied down with a piece of rope.

The body was subsequently identified to be that of one Waiz Khan, who was under the

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* Calcutta Medical Journal, March, 1907.

employment of a Punjabi Mahomedan, named Golam Kader, as a seller of tips of boots. He was last seen alive at about 6 o'clock on the previous evening.

On certain information given by the employer of the deceased, the police at first suspected two persons of Jewish denomination living in the street in which the dead body was found. Subsequently, Golam Kader and two other Mahomedans were arrested and put on their trial on a charge of murder, on the information obtained by the Police from Golam Kader's wife.

The wife stated that she was an eye-witness to the murder. The murder was committed in the house of her husband (12, Kasi Nath's Lane) between 9 and 10 p.m. in the evening of 12th February, 1906. She was in the next room and could see every thing through a chink in the door on the partition-wall between the two rooms. There was a kerosene lamp burning in the room at the time when the murder was committed. She saw the deceased, her husband and another Mahomedan sitting together on a *charpoy*, and her husband offered a smoke to the deceased, asking him to take a strong pull at the *hookah*. The deceased, after smoking the *hookah*, became insensible and the two persons removed him from the *charpoy* to the floor. Her husband held down the deceased and the other man applied a knife to the throat. There was no resistance on the part of the deceased. After this, they

put the dead body in a gunny sack and took it away from the house. The blood-stains on the floor were subsequently washed with water.

The wife made the above statement at the inquest before the Coroner of Calcutta, and again before the Magistrate at the lower Court. At the Kigh Court Sessions, however, she retracted the whole statement.

Several Mahomedans, who were present in the house as co-tenants on the evening of the occurrence, deposed to having heard a kind of gurgling noise proceeding from the room of the accused. It was described like the sound made by a goat when its throat is being cut.

Those who heard this peculiar noise, got alarmed and came to the door of the accused's room which they found barred from inside. On enquiry being made, they were told that a man was lying ill with colic pain in the room and that he was making the gurgling noise. They further deposed to having heard the sound of the moving of buckets and splashing of water, as if something was being washed.

As regards the question of *motive*, it was a mere conjecture in the present case. Jealousy appears to have been the dominant element in whatever motive led to the crime.

Post-mortem examination :—Major J. C. Vaughan I.M.S. (the then Police-Surgeon of Calcutta), who made the postmortem examination of the case, has kindly furnished me with the following notes :—

The throat was cut across from one sterno mastoid to the other, at the level of the Pomum Adami. The wound was obviously of a homicidal character.

The pupils were widely dilated; the bladder contained 27 ounces of clear urine, there being no prostatic enlargement or any obstruction in the urethra. There was no evidence, whatever of injury or contusion after injury, in the subcutaneous tissues any where. The organs, including the brain, were all healthy but anæmic.

The widely dilated condition of the pupils, the absence of all signs of struggle and the distended condition of the bladder led Major Vaughan to suspect that the man had been drugged before the murder. The viscera of the deceased were accordingly preserved for analysis.

Exhibits:—The Police made a thorough search of the house of the accused and they found suspicious-looking stains on a *charpoy* and on a bedstead found in the room of the accused, on the panel of the door and on the mud-floor and walls of the room and on a cooly's basket which was alleged to have been used for carrying the dead body from the house. These articles were sent for detection of blood on them. The Police also sent the stomach, its contents, portions of liver, lungs, spleen and kidney with some bloody fluid of the deceased for detection of poison. The clothes of the deceased, with the gunny sack and the piece of rope, were also forwarded for examination.

The clothes and shoes of the accused, which they had been wearing at the time of the arrest (on the 2nd or 3rd day of the occurrence) were also sent for examination, for detection of blood-stains.

Results of analsyis :—The stains on the clothes of the deceased as well as on the gunny sack and on the piece of rope, contained mammalian blood-cells and *Filaria Nocturna*.

The stains on the *charpoy* and the bedstead were few and small and were confined to some of the legs and one of the sidebars. Mammalian blood cells and *Filaria Nocturna* were detected in these stains.

The stains on the door were on the inner side and lower part of the panel, *facing the interior of the room*. There were numerous small stains in which mammalian blood-cells and *Filaria Nocturna* were detected.

The cooly's basket had a piece of gunny attached to its bottom, which bore a few patches of blood-stains in which both mammalian blood-cells and *Filaria Nocturna* were detected.

The scrapings from the mud-floor of the room, which was alleged to have been washed with water after the occurrence, were found quite damp; no blood was detected in them.

The stains on the mud-wall were very few and faint; they gave reactions of blood but their microscopic examination was negative.

The clothes of the accused were free from blood-stain, except one very dirty handker-

chief belonging to one of them which bore a few spots of mammalian blood, which were old and contained no Filaria. A pair of shoes belonging to one of the accused had two very minute blood spots; microscopical examination failed to discover either blood-cells or Filaria in these stains.

Three knives, belonging to the accused, were also sent for examination; no blood was detected on any of the knives.

The viscera of the deceased were submitted to chemical analysis and *atropine* was detected in them.

Points of medico-legal interest:—The points of medico-legal interest that arose during the trial of the case are the following:—

I. Whether the presence of *Filaria Nocturna* in mammalian blood-stains is corroborative of its human origin.

II. Whether *Filaria Nocturna* could be mistaken for any other filaria occurring in some of the lower animals.

III Whether smoking of Datura seeds would produce intoxication and insensibility.

IV. Whether atropine could be in the stomach-contents and viscera in a case of poisoning by Datura smoking.

I was examined and cross-examined at length, on the above points. My answers to these questions were to the following effect:—

I. There can be no question that *Filaria Nocturna*, so far as our present knowledge goes,

is a human parasite. It has not been discovered in any other animal, except in *mosquitoes which have fed on the blood of persons infected with the* filaria. *As* filarial disease is compara*tively common in this country and as mosquitos abound every where,* it is *difficult* to determine whether a few isolated minute mammalian blood-spots on beddings or clothes, containing Filaria Nocturna, were derived directly from a human being, or from mosquitoes fed on infected blood; but in the case where the stains are numerous, or in large patches (as on the door-panel and on the cooly's basket in the present case), the question of mosquitoes may be at once dispensed with. The presence of Filaria Nocturna in such stains is corroborative of their origin direct from a person infected with the filaria.

II. It is true that certain lower animals are infected with filaria. Janson has found a species of filaria (*Filaria Immitis*) in the blood of a large number of dogs in China, and the same species has also been found in the blood of wolves, foxes and a few other animals. Another species of filaria has also been detected in the blood of the horse and the ass, and this has accordingly received the name of *Filaria Equina.* Filaria has also been detected in the blood of certain birds. It is curious to note that Filaria Immitis is carried from one dog to another through the agency of mosquitoes and that it undergoes a process of development similar to that of Filaria Nocturna in these intermediate

hosts. But in spite of such similarities in the mode of infection and evolution of the two parasites, these are quite different and can be readily distinguished from each other under the microscope. The size and the presence of the sheath in Filaria Nocturna and its absence in Filaria Immitis would make a very material point of distinction between the two as well as other filariæ occurring in mammals other than man. In the case of birds, the character of the blood-corpuscles would make it impossible to mistake the stains for human blood, even if any filariæ are present in them.

After the case was over, it was my privilage to write to Sir Patrick Manson, K.C.M.G., M. D., L.L.D., soliciting his opinion on the above points. I have his kind permission to publish the reply.

21, Queen Anne Street,
Cavendish Square, N.,
8th October, 1906.

DEAR SIR,

Being from home, I had not an opportunity to reply to your letter of 25th August, till to-day.

Filaria Nocturna, so far as is known, *is peculiar to man* but filariæ occur in the blood of many mammals, *though these filariæ are specifically distinct from Filaria Nocturna.*

2. Filaria Nocturna can be recognised by its size, its sheath and the sharp tail.

Filaria Immitis is easily distinguished from Filaria Nocturna ; *Filaria Immitis has no sheath. This is absolutely distinctive* ; the tail, in both, is sharp.

I know of no other sheathed filaria in mammals, although some birds have sheathed filariæ ; but of course, the oval nucleated blood-corpuscles at once show that any filaria such blood may contain cannot be from a mammal.

Yours very truly,
(Sd.) Patrick Manson.

Sir Patrick Manson's reply places beyond all dispute the important question of the significance of the presence of Filaria Nocturna in mammalian blood, which more than once engaged the attention of the Calcutta High Court. In the Bengal Club murder case, tried in the Calcutta High Court in 1900 (reported in Lyon's Medical Jurisprudence for India, 3rd Edition, page 96), Filaria Nocturna was detected in the blood of the deceased as well as in the stains on the shirt of the accused, and I gave similar evidence in that case also. The man was convicted.

III. The other points I had to deal with were whether the smoking of Datura would produce narcotic symptoms, and whether I would expect to find the active principle of the poison in the viscera and contents of the stomach.

My answer to the first part of the question was in the affirmative. Datura is often smoked

in medicinal doses as stramonium cigars in asthma, and also by certain classes of people in India for intoxicating purposes. Both clinical experience and chemical experiments point to the active principle of Datura being volatile to some extent. According to Ladenberg, the alkaloid of Datura is a mixture of atrpoine and hyoscyamine; when heated in a tube, it is decomposed and ammonia is evolved, as with other alkaloids (Taylor's Medical Jurisprudence Vol. II, Page 778). This I submit is rather a misleading statement, as one may be led to conclude that Datura when heated loses its poisonous properties, which is, however, not the case as will be seen from the results of experiments noted hereafter. Blythe says that atropine is slightly volatile, and that hyoscyamine is volatile to a large extent. The experiments which I have made in this connection would show that both pure atropine and the Datura alkaloid become yalatile to an appreciable extent on being heated, and are carried over with the smoke and fumes. Clinical experience fully supports this view. Taylor mentions a case, recorded in the Registrar-General's report, in which the smoking of stramonium cigars for the relief of asthmatic fits was followed by death. It is a practice in some places in India to keep country-liquors in vessels in which smoke of Datura seeds has been introduced, in order to increase the intoxicating power of the spirit. Chevers has

recorded a case in which rapid insensibility followed the smoking of Datura seeds. It is easy to understand that when Datura is smoked, the symptoms of poisoning would appear much quicker than when the poison is introduced into the stomach, as the alkaloid goes with the smoke in very fine division and gets directly absorbed by the blood in the lungs; and when the dose smoked is large, insensibility may at once be produced without the onset of the stage of excitement. Even when Datura is taken into the stomach in the form of a *strong decoction*, insensibility may at once set in without any preliminary stage of excitement. Chevers records a case in which a person swallowed a strong decoction of Datura seeds and *fell down insensibile after he had proceeded* 40 *paces only* (probably within 5 minutes).

The following experiments were made to determine whether atropine and the alkaloid of Datura, when strongly heated, are carried over with the smoke and fumes or not.

Exp.—(1) —A small quantity of atropine was placed in a glass retort to which a long glass tube was fitted leading into a flask in which some spirits of wine were placed, all precautions being taken to prevent the mechanical carrying of the alkaloid from the retort in to the flask. On strongly heating the retort, dense brownish fumes were produced which partly got condensed and deposited at the neck of the retort and in the glass tube, and it partly passed into the flask.

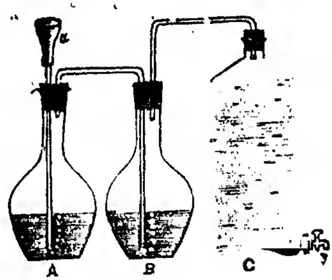
The flask was removed and agitated when the products of distillation became dissolved in the spirits of wine. This was acidulated with a few drops of dilute hydrochloric acid and evaporated to dryness. The residue when applied to a cat's eye produced rapid and wide dilatation of the pupil.

Exp.—(2)—In this experiment, Datura seeds were employed instead of pure atropine, the other conditions being the same as in the 1st experiment. The result was identically the same, much atropine being detected in the products of distillation.

I was discussing the matter with Major Vaughan when he suggested to me the following experiment which was conducted in a way that would correspond with conditions under which Datura is ordinarily smoked in this country and which was alleged to have been followed in the present case. This experiment gives remarkable results, for it shows that the fumes of burning Datura seeds retain the alkaloid even when allowed to pass successively through water and rectified spirit.

Exp.—(3)—A flask (A) nearly half-full of water was fitted with a cork with two holes in it through one of which a glass tube reached the bottom of the flask and to this glass tube, the *chillum* (a) containing bruised Datura seeds was tightly fitted as in a *hookah*, a fine wire-gauze having been first placed in the *chillum* to prevent mechanical carrying down of the

seeds. The other hole in the cork admitted a glass tube bent twice at right angles reaching the neck of the flask only. The other end of the bent tube was connected with another flask (B) arranged in the form of an ordinary wash-bottle in which some spirits of wine were kept.



The flask B was next connected with a bottle-aspirator C entirely filled with water. Fire was then placed on the Datura seeds in the *chillum* and on opening the stopcock of the aspirator, the fumes and smoke of the burning Datura seeds were carried successively through water and spirits of wine in A and B respectively and they filled the bottle C; a quantity of the fumes remained also in A and B. The fumes were allowed to subside, the contents of each of the three bottles well shaken, acidulated with a few drops of dilute hydrochloric acid and evaporated to dryness. *The residue in each case when applied to a cat's eye caused dilatation of the*

pupil. It will be seen from the arrangement of the apparatus that no particles of Datura seeds could be mechanically carried from the *chillum* into the 2nd flask (B) or into the aspirator bottle (C); even neglecting the presence of atropine in the first flask (A) which was in direct contact with the *chillum* (a), the detection of atropine in B and in C would leave no doubt as to the volatile character of the alkaloid and its being carried over with the smoke of the burning Datura seeds.

IV. In *poisoning by Datura-smoking*, one would not ordinarily expect to detect the poison in the contents of the stomach. In the present case, it was impossible to say where the atropine detected by chemical analysis lay, as the stomach and its contents had been sent along with lungs, liver, spleen and kidneys and some blood of the deceased in one and the same jar. One would certainly expect to detect atropine (unless eliminated from the system before death) in the blood and blood-containing viscera (such as liver, spleen and lungs) in a case of death by Datura smoking, but its presence in the stomach-contents only in such a case is rather doubtful, and no opinion can be given on this point without actual experiment.

Result of the trial:—The case was tried twice at the High Court Sessions. At the first trial, the jury returned a verdict of guilty against the accused by a small majority only, which was not accepted by the Judge who discharged

the jury and ordered a fresh trial. In the second trial, the case had been partly gone into, when some of the witnesses were consideraed to be unreliable and the accused were accordingly discharged.

In conclusion, I have to acknowledge with thanks the help I received from Dr. Hiralal Sinha, Asst. Chemical Examiner, in making the above experiments.

A Fatal Case of Poisoning by Arsenite of Copper.

INTRODUCTORY REMARKS.—Fatal cases of poisoning by Arsenite of Copper are not of frequent occurrenee. So far as this Province is concerned, I have not come across a single case during my 24 years' connection with the Calcutta Laboratory, and looking into the records of a few previous years, I have failed to find out a case in which death had been ascribed to the ingestion of Arsenite of Copper. On the Bombay side, however, a few non-fatal cases have occurred and Colonel Barry, I.M.S. has recorded one of these in his work on Legal Medicine. In this case, two Parsis ate some green sweetmeat and began to vomit after half an hour. The sweetmeat was coloured green with Arsenite of Copper. Both the patients recovered. In another case mentioned in Lyon's Medical Jurisprudence for India, a child of ten months suffered from symptoms of irritant poisoning, the result of sucking the paint of a toy-parrot painted bright-green with

* Calcutta Medical Journal, July, 1910.

Arsenite of Copper. There are a few cases, both fatal and non-fatal, recorded by Taylor, in which the poisoning took place either by taking sweets coloured with this poisonous pigment, or from inhalation of air of rooms the walls of which were covered with papers painted with Arsenite of Copper. Fortunately, wall-papers are seldom used in India for decorating rooms and hence the risk of poisoning from this source is practically *nil* in this country. Chevers, however, records one Indian case in which poisoning resulted by sleeping in rooms the walls of which were painted with Arsenite of Copper.

NATURE OF THE POISON.—Arsenite of Copper is known in commerce under two different names, *viz.*, Scheele's Green and Schwinfurth's Green or Emerald Green, with slight difference in their chemical composition. Scheele's Green is pure Arsenite of Copper, while Emerald Green is a mixture of Copper Arsenite and Copper Acetate. Both are of an attractive bright green colour, insoluble in water but readily soluble in caustic potash and caustic soda and in dilute acids. They are dissolved by the acid fluid of the stomach. They give rise to symptoms of irritant poisoning when taken internally or inhaled in the form of fine dust. They are largely used for making wall-hangings and wall-papers and in colouring toys and sweetmeats by ignorant people. This pigment is known in this country as HIRWA. It is seldom

used for homicidal or suicidal purpose. Lyon records two cases of attempted homicide in which this poison was used, but the act was detected in time and the victims escaped. Cases of accidental poisoning by this substance have been recorded. Poisoning by Arsenite of Copper, however, usually occurs either by taking sweetmeats which have been coloured with the material through ignorance, or by inhaling the poisoned air of rooms painted green with the arsenic compound. In the latter case, the symptoms observed are of chronic arsenic poisoning.

HISTORY AND SYMPTOMS.—The case which I am going to describe in this paper, is one of suicide which occurred in Calcutta in May, 1910. It proved fatal within 6 or 7 hours. A Mahomedan woman, aged 17, living in the Muchipara section of the town, had a quarrel with her husband. On the morning of the 18th May, she was chastised and assaulted by him. The husband also warned the wife not to have any thing to do with a neighbour, a lad of 15, with whom he thought his wife was on too friendly terms. After this, the husband went to work at about 9 a.m., leaving his wife in the house weeping but in her usual health. He returned at about 6 o'clock in the evening and found his wife in a moribund condition brought about by severe vomiting and purging. The sister of the husband, who lived in the same house, stated that she found the deceased vomiting

and purging at about 11-30 a.m. She attended the sick woman and noticed that the vomited matter was green, which led her to suspect that she had taken some green paint kept in the house. The husband was a painter and he used to keep all kinds of paint including Arsenite of Copper in a broken wooden box to which anybody living in the house had ready access. The deceased refused to say what she had taken. A medical man was called at about 5 p.m. He found the woman gasping and in a dying condition and would not prescribe for her. She died in the house a short time after her husband's arrival. Some of the relatives advised private burial but the Police got timely information and had a Cononer's inquest in the ease.

POST-MORTEM APPEARANCES :—The police Surgeon of Calcutta held the *post-mortem* examination on the morning of the 19th May, 1910. The body was well-nourished and *rigor mortis* was present in the lower extremities. The lungs and the kidneys were healthy but congested. The right cavity of the heart contained a considerable quantity of organised ante-mortem clot; there was some blood in the left cavity. The valves were healthy. The mucous membrane of the gullet was whitened and friable. The gastric mucous membrane was œdematous and slightly echymosed at the more dependent parts. The stomach contained about 1½ ounces of a brownish grumous material. The duodenum

was congested. The large intestine contained some liquid fœcal matter. The liver, the spleen, the uterus and the ovaries were healthy. The condition of the gulllet and the stomach was suggestive of slight corrosive, besides irritant, action of the poison. The Police Surgeon considered that death was due to irritant poisoning and he forwarded the viscera to the Chemical Examiner for analysis. The Police also sent the wooden box containing paints which was found in the house, as well as some clothes on which the deceased vomited, for chemical examination.

Chemical Analysis :—Arsenic was detected in the viscera of the deceased. There were a few faint greenish patches on the mucous membrane of the stomach which were undoubtedly caused by the deposit of Arsenite of Copper, but owing to its minute quantity, the substance could not be satisfactorily identified.

The dried up vomited substance on the clothes revealed the presence of several bright green particles which, on analysis, were found to be Arsenite of Copper.

The wooden box contained different kinds of pigments and painter's brushes. With the exception of a bright green pigment, none of the others contained arsenic. The bright green

pigment was found to be Arsenite of Copper. It was identified to be the same substance as that found in the vomit of the deceased.

CONCLUSION:—The Police Surgeon, on hearing the Chemical Examiner's evidence, gave his opinion that death was caused by Arsenic poisoning and the Jury accordingly returned a verdict of death by poisoning by Arsenic self-administered.

I have to thank my colleagues, Drs. Hiralal Sinha and Beni Madhab Chackraberti, for much assistance in the examination of the case.

Cocaine Poisoning.

Not many years ago, Cocaine was a drug hardly known to the people of India outside the medical profession, and now, sad to reflect, it has taken a vigorous hold of a certain class of people in this country, both in towns and villages. In Calcutta, despite the vigilance of the Excise authorities and notwithstanding the stringent measures directed by Government against the possession and sale of this substance by unlicensed persons, there is reason to believe that the Cocaine-habit has much increased and* is rapidly spreading. Moreover, it is perhaps safe to say that a considerable proportion of the crimes committed in this city may be traced to the utter moral depravity which follows the habitual use of cocaine. The daily papers are full of the reports of raids on cocaine-dens and of cocaine-seizures, and the references made to the Chemical Examiner in connection with the illicit import and the unlawful possession of cocaine are rapidly and progressively on the increase, as may be seen from the figures given below compiled from the Annual Reports of the

* British Medical Journal, January 4th, 1913.

Chemical Exaimner's Department, Bengal, for the last four years :—

Year.	Number of samples of cocaine seized and sent for examination.
1908 ..	125
1909 ..	243
1910 ..	621
1911 ..	2138

Although the Cocaine-habit has been described by Erlenmeyer as the third scourge of humanity, the two first being alcohol and opium, yet in some respects, cocainomania is more disastrous in its effect an the moral, intellectual and the physical well-being of the subject. Prof. Berkley of the John Hopkins University has observed that he would trust a "cocaine-debauchee even less than he would a morphinomaniac, stating as his reason that the moral rectitude and the will-power of a cocaine-eater always suffer more seriously.

In Taylor's Principle and Practice of Medical Jurisprudence, it is said, referring to chronic cases, that "*like morphia, the habit of cocaine seems to sap the moral fibre of its devotees, so that they become reckless of everything in their efforts to obtain their dose; lying, cheating, stealing—nothing comes amiss to them so that their craving is satisfied*"

Dr. A H. Brundage, Professor of Toxicology in the Brooklyn College of Pharmacy,

remarks that the cocaine-habit "*is the most seductive, dangerous and mentally, physically and morally destructive of all the drug-habits. Cocaine fascinates by the promptness with which it relieves all sense of exhaustion, dispels gloom and exhilerates, producing a sense of happiness and well-being—which transports at once to a longed-for elysium. Primarily, the after-effects are scarcely perceptible, but through continual indulgence, an intense craving for the drug or its effects is produced.*"

It is the utter banishment of gloom and the delightful sense of *bien-etre* which together are directly responsible for the intense craving characteristic of the habit and productive of physical, mental and moral degradation and depravity which ensue.

Prof. Berkley reports that the body-weight sinks rapidly, even $\frac{1}{5}$ to $\frac{1}{3}$ of it being lost within a few weeks.

Dr. Kailas Chandra Bose (now Sir), C.I.E., in the March number of the Indian Medical Gazette, 1902, recorded several cases of the habitual use of cocaine, and summarized the principal symptoms noticed. These were :— headache, anorexia, emaciation, insomnia, a blackening of the tongue and teeth; dilated pupils; rapid and feeble, sometimes irregular or intermittent pulse; fainting attacks; hallucinations; incoherent speech and convulsions. In one case, there was obstinate diarrhœa and in another, there were symptoms of actue mania.

PROGNOSIS :—Prof. Berkley observes that the prognosis is "most gloomy, for even though the patient recovers from one attack, he very frequently relapses into his evil habits. In the most favourable cases, there remains an extraordinary weakness of the will-power, with accentuated tendency to relieve the physical and psychical langour by substituting for the cocaine alcohol, morphine and other nervines in large quantities."

DOSE :—The medicinal dose of the Hydrochlorate of Cocaine is $\frac{1}{5}$ to $\frac{1}{2}$ grain. The minimum fatal quantities on record are $\frac{2}{3}$ grain hypodermically , 12 to 15 grains by the mouth and 22 grains by rectal injection.

A few cases have been recorded in European practice in which the drug either proved fatal or produced very severe symptoms when it was injected hypodermically or passed into the natural cavities prior to a surgical operation, or administered internally. In one case, the injection of $3\frac{1}{2}$ grains into the breast of an adult woman was immediately followed by epileptiform convulsions, and in 20 minutes by death. In another instance, the hypodermic use of $\frac{2}{3}$ gr. in a woman aged 71, proved fatal in 5 hours. In the Pharmaceutical Journal 1886, (iii) 16, 721, a case is recorded in which the hypodermic injection of $\frac{1}{20}$ grain caused dangerous symptoms in a girl aged 12 years. On Nov. 2nd, 1895, a case was reported in the Lancet, in which two drachms of a 10% solution of cocaine

(representing 12 grains of the drug) taken internally for the relief of tooth-ache caused death in 20 minutes with epileptiform convulsions. In another case, $\frac{1}{100}$ grain applied locally to the conjunctiva gave rise to dangerous symptoms; while in still another instance, acute manifestations followed the injection of $\frac{1}{2}$ drachm of a 10% solution (i.e. grains iii) into the urethra. A rectal injection of 22 grains of cocaine has been productive of death. The prominent symptoms in all these acute cases of poisoning consisted of dryness and numbness of the mouth and throat; vertigo; dyspnœa; failure of the special senses of sight, hearing and smell; numbness of the extremeties; rapid and feeble, sometimes irregular or intermittent pulse; muscular tremors; a staggering gait; dilated pupils; epileptiform, sometimes tetanoid, convulsions; cyanosis and insensibility.

The practical lesson to be learned from cases like these is the extreme care which is necessary in administering the drug for the production of local anæsthesia in dental practice and surgical cases.

No case has yet been recorded in Indian medical practice, so far as I have been able to ascertain, of acute cocaine-poisoning with a fatal result. In the 27 years during which I have been connected with the Chemical Examiner's Department in Bengal, I have not had a single case of fatal cocaine-poisoning referred to me except the three which I am about

recount, all of which occurred within the past 6 months. Not only does this fact appear to indicate that the drug is very easily procurable by the common people inspite of the strict regulations against it but it also seems reasonable to infer that the people are getting to be more familiar with the uses to which the substance can be put.

CASE I.—B. D., a Hindu male, aged about 23 years, a resident of Calcutta and by occupation a press-man was addicted to alcohol and to cocaine. On May 28th, 1912, he played cards with his friends up to a late hour of the night and distributed *pan* (betel) with cocaine to his companions, taking the largest share himself. He left the place soon after and at 2-30 a.m., on May 29th, he was found lying unconscious and groaning at a neighbour's door-way. Medical aid was summoned, the man was removed to hospital but died on the way there.

Post-mortem appearances:—Body poorly nourished; rigor mortis present; pupils normal. The lungs, the kidneys, the brain and its membranes and the mucous membrane of the stomach were found congested. The stomach contained about 2 ounces of recently taken food without any special odour.

Chemical analysis:—The viscera of the deceased and a small quantity of urine found

in his bladder were forwarded to me for chemical analysis and I detected cocaine in both. I could detect no other poison in the viscera.

The dose taken by the deceased could not be ascertained.

Case II. K., a Hindu female, aged about 28 years, a woman of the town, was in the habit of taking cocaine. She left home at about 1-30 a.m. on August 29th, 1912 and returned at 6-30 a.m. She was seen to be staggering while washing her mouth at a hydrant hard by. Very soon afterwards, she lay down, became unconscious and in a few minutes, she died.

Post-mortem appearances:—Body fairly nourished; rigor mortis present; pupils slightly contracted; there were no marks of violence on the body.

The brain and its membranes, the liver, the spleen, the kidneys, the ovaries, the bladder and the mucous membrane of the stomach were found congested. The right heart was dilated and contained dark fluid blood.

The stomach contained about 3 ounces of recently taken vegetable food without special odour.

Chemical Analysis:—The viscera in the case were sent to me for chemical analysis and I detected a marked quantity of cocaine in them. I detected no other poison in the viscera.

Neither the dose taken nor the fatal period could be ascertained in this case.

CASE III.—M. K., a Hindu female, aged about 20 years, lived with her husband in Calcutta. On October 17th, 1912, she visited her sister-in-law. L. K., and at about 7 p.m. on the following day, she offered her some white powder which she believed to be a specific remedy for acidity and indigestion. They each took some of the powder and within half an hour, they became ill and then unconscious. M. died soon after, but L. regained consciousness about 4 hours later and recovered at the Medical College Hospital.

Post-mortem appearances:—Rigor mortis present; body well nourished; pupils slightly contracted; there were no external marks of violence visible.

The brain, the meninges and the lungs were highly congested. The liver, the spleen, the kidneys, the larynx, and the trachea were also found congested. The stomach contained about 9 ounces of sour-smelling food.

Chemical Analysis:—The viscera were forwarded to me for chemical analysis and I detected cocaine in them. There was no other poison present in the viscera.

The dose taken by the deceased could not be ascertained but death took place in this case in about half an hour.

CASE IV.—The case of L. K., sister-in-law of victim No. 3, constitutes a fourth case but it did not terminate fatally. The dose taken rendered the patient unconscious in half an hour

and kept her so for four hours. Her pulse and respiration are said to have been normal during her stay in hosptial and her pupils slightly dilated.

The stomach-washings were sent to me for chemical analysis and I detected cocaine in them but no other poison.

METHOD OF DETECTION :—In all these cases, I detected cocaine by Stas's process. The dry ethereal extract, on being applied to the tongue, produced very marked anaesthesia. When this was disolved in dilute hydrochloric acid and evaporated to dryness on a water-bath, it left a residue which gave well-marked reactions with the principal alkaloidal reagents.

The hydrochlorate thus obtained, when treated with a solution of picric acid, gave a copius precipitate which, under the microscope, showed the usual long needles arranged in star-shaped bundles.

A fresh portion of the residue treated with a drop of strong solution of alum and next with a drop of Pot. permanganate solution yielded a deep reddish-brown precipitate, the latter under the microscope showed the characteristic rectangular plates.

Another portion of the residue was treated with strong nitric acid and evaporated to dryness. The addition to it at this stage of a few drops of an alcoholic solution of potash caused the characteristic peppermint-like odour of Ethyl Benzoate to evolve.

A five per cent. solution of chromic acid added to a solution of the hydrochlorate produced an abundant precipitate which disappeared on shaking. The subsequent addition of a drop of strong Hydrochloric acid caused a copious yellow precipitate.

TREATMENT :—As regards treatment in an acute case, the stomach-pump should be used, as the anæsthetic effect of the drug on the mucous membrane of the stomach might interfere with the action of an emetic. Hot coffee and stimulants such as brandy, ether and ammonia should be freely given, and hypodermic injections of ether, strychnine and digitalis might be desirable. In convulsions, I may say that chloroform is useful. Morphine appears to possess an antidotal action against cocaine and it might be used hydopdermically. Inhalation of Amyl Nitrite has also been recommended. Perfect rest in a lying position should be enjoined in all cases.

My best thanks are due to Capt. St. John Moses, M.D., D.SC., F.R.C.S., F.R.S.E., I.M.S., Police Surgeon of Calcutta, for kindly supplying me with the notes of the *post-mortem* examination of the three fatal cases.

Two Cases of Poisoning by White Lead.*

Cases of lead-poisoning, although not so common in this country as in Europe where they occur chiefly in connection with the manufacture and use of lead salts for commercial purposes, do occur here oftner than is generally believed to be. In Europe, people come into contact with lead in one or other form in so many ways that it seems rather surprising that more cases of poisoning by this metal do not come to our notice. A perusal of the recorded cases of lead-poisoning will show the multiplicity of ways in which lead may find opportunity to enter into our system and produce the toxic action. It is quite probable, however, that many cases remain undetected owing to faulty diagnosis. The usual gastro-intestinal symptoms of lead-poisoning; *viz.*, vomiting, constipation and colic are often attributed to dyspeptic troubles, and thus the real cause of the disease escapes notice. It is only when typical nervous symptoms supervene that the

* Calcutta Medical Journal, February, 1916.

real cause is discovered and proper remedy applied to give relief. Recently two cases of lead-poisoning were brought to my notice by Dr. Jatindranath Bose, Asstt. Surgeon under the Govt. of Bihar and Orissa, which are worth recording, as they had not only an interesting history but showed some of the typical sysmptoms. These were cases of accidental poisoning by *white lead.* I had an opportunity to see both the cases and chemically examine the offending substance, and also the urine of one of the patients (nearly a month and a half after the ingestion of the poison) in which I obtained distinct reactions of lead.

It is satisfactory to note that the adoption of preventive measures, such as improved methods of manufacture, sanitary improvements and systematic medical inspection of factories, has produced remarkable results in reducing the death-rate from lead-poisoning in England. Thus in 1891, according to the statistics collected by Sir Thomas Stevenson, no less than 132 fatal cases of lead-poisoning occurred in England and Wales, whereas only one fatal case was recorded by the Registrar-General in 1901.

It may be stated here that lead is usually not immediately dangerous to life, as recovery from large doses of the poison is quite common, and that it is more dangerous in the chronic than in the acute form of poisoning, because once it has obtained access into the tissues, it is removed therefrom with exceeding slowness.

It will not be out of place if I give here a short account of the poisonous compounds of lead with symptoms and treatment of lead-poisoning and such statistics of cases as I have been able to collect for the information of my readers.

POISONOUS SALTS OF LEAD.—The most soluble salts of lead are the acetate (commonly known as sugar of lead) and the nitrate. Lead acetate is used as a medicine both internally and externally, its dose being from 1 to 5 grains, but it has been used in much larger doses (18 grains or more daily for 10 days) without untoward symptoms. There are many cases on record in which one ounce of the salt caused severe acute symptoms. No other salt of lead is used internally for medicinal purposes. Acetate of lead has been known to be used to sweeten cheap wines. It need hardly be observed that such use of the salt is most reprehensible. I have not seen any recorded case of poisoning by nitrate of lead which, I believe, to be more powerful in its action that the acetate.

Among the slightly soluble and insoluble com pounds of lead may be mentioned the chloride, the monoxide (litharge or massicot), red lead, white lead (basic carbonate), the chromate, the iodide and the sulphate. White lead is more responsible for accidental cases of lead-poisoning than any other lead compound. It is the most extensively used for all lead-compounds

and forms the principal ingredient of white paints; it is also used as a cosmetic and for glazing cards and the white leather-lining of hats. It enters into the composition of varnish for the canvas of painters.

There are many cases on record of poisoning by the oxide of lead known as red lead (minium, *metia sindoor*) which is largely used as a red paint. It is also used in the manufacture of glass and of the glaze for pottery.

The monoxide of lead (litharge, *mudra-sankha*) is slightly soluble in water and is responsible for a number of cases of chronic poisoning both in India and in Europe. Both the red and this oxide of lead have been used in India for causing criminal abortion.

Poisoning by chromate and iodide of lead, both of which are used as pigments, is not at all common.

The sulphate of lead is a very insoluble salt and may be ordinarily regarded as an inert substance, although cases are recorded of semptresses being poisoned by sucking thread mixed with sulphate of lead, so used for the purpose of increasing the weight of the thread.

Metallic lead, accidentally swallowed, has been known to give rise to symptoms of chronic poisoning. Farinacious foods wrapped in lead foil and chocolate wrapped in spurious tinfoil (lead foil with a thin coating of tin) have been known to cause symptoms of lead-poisoning in children. Bar-men who have constantly

to handle pewter (an alloy of lead) pots have been known to suffer from chronic lead-poisoning, and compositors handling types (alloy of lead and antimony) frequently suffer from lead-colic.

Taylor in his book on "Poisons" mentions cases in which people suffered from colic and paralysis by sleeping in newly-painted rooms.

Acids and alkaline or fatty substances should not be stored in lead-glazed vessels as the contents are apt to be contaminated with lead by chemical action. Food-articles should never be stored in lead-vessels or in tins soldered with lead.

Some kinds of hair-dye contain lead as one of their ingredients and cases are known of chronic poisoning following the long-continued use of such stuffs.

SYMPTOMS. The soluble salts of lead are highly poisonous. They give rise to symptoms of a narcotico-irritant character. The irritant symptoms such as burning sensation in the mouth with an unpleasant metallic taste, nausea, vomiting &c., appear first, followed with greater or less severity by disturbances of the nervous system, such as violent colic relieved by pressure, spasms, convulsions, cramps in the extremeties, paralysis, mental abberration, delerium and coma.

The action is often slow and insidious and may run for months or years. Acute symptoms follow the ingestion of large doses of the

poison, but after their subsidence, symptoms of chronic poisoning persist and may ultimately end in death from exhaustion and nervous troubles. Chronic poisoning by lead is of more frequent occurrence, the cases being mostly accidental, found among workers with white or red lead.

Obstinate constipation is one of the prominent symptoms of chronic lead-poisoning. The countenance usually becomes pale, shallow and anxious, the tongue flabby coated with a white fur, a blue line appears at the edge of the gums joining the teeth, sickness on taking any food; there is intermittent colic and the pulse is quick and feeble. The mental faculties remain undisturbed. There is emaciation with paralysis of a peculiar kind affecting the extensor muscles, causing dropping of the wrist or general paralysis of the limbs. The paralysis first affects the extensor muscles of the fore-arm causing *wrist-drop*.

SOURCES OF POISONING.—The sources of lead-poisoning are as varied as they are interesting, as some of the cases noted below will show.

There are numerous cases on record in which either the acetate or the sub-acetate of lead had been the toxic agents. In one case, it had been mixed with corn by mistake for alum, and 500 persons who used those grains were attacked with violent symptoms of lead-poisoning. In other cases, lead acetate was

taken in repeated doses medicinally for days or weeks followed by severe symptoms, in one case attended with death. A child sucked the breast of its mother to which Gouldard's lotion had been applied. It suffered from colic and died on the 11th day. A man took a quantity of Goulard's lotion mistaking it for wine; he had colic, lock-jaw and convulsions, and died on the 3rd day. In one case, the external application of an ointment containing sub-acetate of lead to a sore daily for a month, was followed by lead-paralysis, but the patient recovered.

There are many cases on record of poisoning by red lead (*metia sindoor*) which is so largely used as a red paint. It was accidentally taken with beer by 27 persons who all developed blue lines on their gums and suffered from colic and constipation. They all recovered. Cases are on record in which persons got poisoned by the use of snuff to which red lead had been mixed to improve its color. There is one case on record in which red lead with shellac was used to solder water-pipes, and people drinking water led through these pipes showed symptoms of lead-poisoning attended with wrist-drop and facial paralysis.

Lead shots were swallowed in one instance and on the 3rd day, symptoms of depression, collapse, constipation, and numbness in arms and legs were noticed; recovery took place in a fortnight.

There is a case on record where a whole family was poisoned by taking bread made from flour which had been accidentally mixed with white lead; and in another case, dusting the skin about the back and ears with powdered white lead was followed by symptoms of poisoning. It is quite probable that in this last case, some of the powder was inhaled during dusting. Severe symptoms of lead-poisoning occurred in a healthy robust person who lived 3 days in a freshly-painted house. There was no colic but there were headache, vomiting, constipation, and right hemiplegia. Blyth records five cases of lead-poisoning occurring in a white lead factory in which the symptoms were of a mild character but all the affected persons died suddenly, and in the case of four of them, death was preceded by fits.

A case is on record in which poisoning took place by drinking beer which was allowed to stand in the lead-pipe of the beer-pump all night. In the Lancet of Nov. 11, 1887, a very interesting case is recorded in which 11 persons suffered from *plumbism* by taking tea which was wrapped in lead-foil.

Lead has a specific action on pregnant uterus. Blyth records 36 pregnancies in women suffering from chronic lead-poisoning in which there were 26 abortions, 1 premature confinement, 2 still-births, and 5 live-births of which four children died within a year. Red lead, as already stated, is used in this country for

inducing criminal abortion. Two English cases were reported in the British Medical Journal, 1893 and in the Lancet, 1898 in which *diachylon* (made of red lead) was taken in plaster and pill forms respectively to procure abortion, followed by poisoning and fatal results.

ACTION OF DRINKING WATER ON LEAD.—Drinking water stored in lead-cisterns or passed through lead-pipes often dissolves a small quantity of lead, and such water, if consumed for some time, gives rise to symptoms of chronic lead-poisoning. There is a case on record in which a number of persons suffered from colic, vomiting and constipation by using town-water containing ¾ grain of lead in a gallon; some died and lead was detected in the viscera. 13 to 38 persons belonging to an Ex-Royal family of France suffered from symptoms of chronic lead-poisoning by using water passed through lead pipes, and in the Lancet, 1894, a case has been recorded in which plumbism occurred in a family of husband, wife and child by using water from a boiler with a *lead-worm.*

This solution of lead in water depends upon the nature of the water passed through lead-pipes. If the water is soft, it attacks the lead of the pipes forming the nitrate and chloride which become dissolved in the water and a fresh surface of the lead-pipe is again exposed to the action of the water. As fresh water always contains air, a thin film of lead oxide is also formed on the inner surface of the tubes

and as lead oxide is slightly soluble in water, it becomes dissolved and a fresh formation of the oxide takes place. If the water is hard and contains much sulphates, an insoluble layer of sulphate of lead forms on the surface of the pipe and further action of the water on the lead of the pipe is thus prevented. In the case of hard waters which contain much carbonates, a similar insoluble coating of lead carbonate is formed which prevents further action of the water on the lead-pipe. But if the water also contains much carbonic acid gas in solution, the carbonate of lead becomes soluble in excess of carbon dioxide and thus the lead-pipe is again exposed to the action of the water. Generally speaking, waters containing much chlorides, nitrates and carbonic acid gas in solution should not be allowed to be stored in lead-vessels or passed through lead-pipes, as they form soluble lead salts. Hard waters containing much carbonates and sulphates have a protecting action on lead and, therefore, there is no danger in allowing such water to pass through lead-pipes or stored in lead-cisterns.

Treatment.—In acute cases, an emetic such as zinc sulphate, should be administered and a brisk purgative, such as a big dose of magnesium sulphate with sulphate of soda should be given, to help the elimination of the poison by the bowels. These sulphates would also transform the soluble lead salt into the

insoluble lead sulphate and would thus act as chemical antidotes.

After the bowels have freely moved, opium should be given to relieve colic and spasm. A combination of morphine and atropine given hypodermically gives most relief in lead-colic.

In chronic poisoning, efforts should be directed to the elimination of the lead from the system; a mixture of sulphate and carbonate of magnesia has proved beneficial in such cases. Some recommend iodide of potassium but others consider this drug to be of doubtful value.

Frequent warm baths and plenty of nourishing food with codliver oil give best results in chronic lead-poisoning cases.

Now, I shall briefly record the history, the signs and the symptoms exhibited by the two cases seen by me.

CASE I.—B. N. M., a Hindu male age 44, a resident of Dakshin Sripur in the District of Khulna and by occupation a *teshildar*, was staying in a pleader's house at Satkhira, with his friend (Case II) where they had gone to instruct their legal adviser in certain cases. While there, they took some betels prepared by their servant which tasted bitter and this was attributed to bad catechu with which the betels were prepared. The catechu was changed from day to day, but yet this bitter taste of the betels did not improve. On the 4th day, he and his friend began to vomit and suffered from severe colic pain in the abdomen. He took some in-

digenous medicines but did not find much relief. The vomiting recurred daily 4 or 5 times and the colic pain regularly returned every evening and lasted for the whole night. A medical man was at last called who attributed the troubles to dyspepsia and gave some medicines which did not give any relief. On closer investigation, it was found that the servant had by mistake used *white lead* for lime in preparing the betels for his masters. The house was being repaired and painted, and slaked lime and some *white lead* were stored in the same place side by side. The servant wanted lime for the betels and was shown the place where the lime was lying. He picked up the *white lead* thinking it to be lime and prepared the betels day after day for his masters with this substance.

The patient stated that the colic for the first four days began at the region of the descending colon and thence spread all over the abdomen. It was relieved by pressure and was attended with constipation and flatulence. The pain gave him no sleep at night and sometimes he used to talk incoherently. He did not notice any weakness in the limbs, nor any tremors. He had bleeding from the gums for a few days after the poison had been taken.

When seen by me about a month after the ingestion of the poison, the patient was found to be strong and muscular but markedly *jaundiced*. There were *very distinct blue lines* on the gums.

The tongue was pale, coated with a thin white fur in the centre. *Bowels strongly constipated*. moved only on taking purgatives. He had no motions for some days in his native village which made him come to Calcutta for relief. There was loss of appetite, tenderness over the descending colon and slight flatulence. He passed high coloured and scanty urine.

Lungs ... Normal; respiration, 20 per minute.
Heart ... Normal; pulse beat 90 ,,
No enlargement of liver or spleen.
No wrist-drop; knee-jerk normal; no signs of neuritis.

Five days after his arrival in Calcutta, he had a severe fit, his limbs became stiff, the eyes were fixed, he lost consciousness for about an hour and the bowels were tympanitic. These symptoms slowly passed off.

CASE II.—M. N. B., a Hindu male aged 40, took the same betels with the case No. I in the house of the pleader at Satkhira. He also noticed a bitter taste each time he took the betels. The symptoms in his case too began with vomiting on the 4th day and he suffered off and on from intestinal colic. He noticed an increased flow of saliva and had no sleep for about 20 days after taking the poisoned betels. His urine was free but his bowels were very constipated.

When I saw him, he was very poorly and anæmic. He was subject to malarial fever but had no attack since the ingestion of the poison. There was no enlargement of the liver

or spleen. The heart-sounds were normal; pulse very soft and small but regular, 116 per minute. The respiratory sounds were normal; the number of respirations per minute was 22. No paralysis; no tremors; no signs of neuritis. The knee-jerk was normal. He was very much constipated and suffered from nausea and occasional vomiting. He was still getting colic and the eyes were slightly jaundiced.

There were distinct *blue lines* on both the gums. He complained of much burning sensation in the head, and now and then, suffered from headache. He had lost appetite.

There was no paralysis or weakness in the extensor muscles of the forearm.

CHEMICAL ANALYSIS. The offending substance which was used by mistake for lime in preparing the betels was examined by me and found to be *white lead*. This is a basic carbonate of lead, much used for making white paints.

The urine of one of the patients was also analysed. It contained traces of albumin and bile only. The urine was evaporated to dryness, the residue treated with diluted nitric acid and filtered. The filtrate gave distinct reactions of lead with the usual reagents; it was, however, too small for quantitative examination.

SUBSEQUENT HISTORY.—The patients were treated with big doses of sulphate of magnesium and sodium, and iodide of potassium was also

given in 5 grain doses, thrice daily. Morphine was given when necessary to relieve the colic.

They remained under this treatment for about a month when they felt much better, the distressing symptoms such as vomiting, colic, constipation &c. greatly relieved, when they left for their village-homes. No further information has been obtained about these cases.

Paka-Oil in Mustard Oil as an Adulterant.*

In July last, our attention to this matter was first drawn by Dr. Satya Saran Mitra of Howrah, who reported a few cases of illness showing symptoms of gastro-intestinal irritation accompanied by giddiness and a sense of general weakness and faintness, which came under his observation in Howrah and Sibpur. He suspected mustard oil with some new adulterant, used as food, to be the cause of this illness. Subsequently, several cases of a similar nature were reported in the newspapers, occurring in Calcutta and its suburbs, and some medical practitioners who saw the cases also suspected adulterated mustard oil to be the cause of the illness.

Dr. Mitra was good enough to send us a few samples of the suspected mustard oil used in the suffering families, and also a few seeds which he obtained from some oil-mills in Howrah and which, he came to know, were being mixed

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with mustard seeds for the extraction of the edible oil which is indispensable as an article of food in every Bengali house.

Almost simultaneously, Dr. Sasi Bhusan Ghosh, M.B., Chief Analyst to the Corporation of Calcutta, received information regarding the incidence of such cases and had reasons to suspect the use of bazar mustard oil to be its cause. We had a talk with him about this matter and he kindly sent us a quantity of seed, with some oil expressed from some more at the Indian Museum, for chemical and physiological experiments. These seeds were identified at the Museum as *Paka* seeds of the lac tree (Bot. name "Schleichera trijuga") and the oil expressed from these seeds is generally known as Macassar oil, *Paka* oil or *Kusum* oil.

Botanical character and uses.—The plant Schleichera trijuga belongs to the natural order Sapindaceæ, to which the common Indian plant soap-nut or *Rita* belongs. It is known also as the "Kusum" tree of India, lac tree of Kosumba and Ceylon oak. In the Celebes, the seeds are known as Kosumbi nuts.

The wood of the tree is very hard, strong and durable like oak, hence it is called Ceylon oak. It is used all over the country for the making of oil, rice and sugar mills and of agricultural implements and carts. Lac is produced on the young branches of the tree.

The fruit is a drupe of the size of a nutmeg, a little pointed, with a grey fragile husk cover-

ed with soft blunt prickles. The seeds are surrounded with a whitish pulpy aril having a pleasant acid taste. This pulp is edible and palatable. The dry seed is hard, of a brown colour, oval and smooth, length about half-inch at its longer diameter, with a pointed hylum at one of its ends, and a small depressed longitudinal mark on each side. The kernel occupies the whole of the interior of the shell and consists of a smooth body with a deep cut from the hylum close to the centre of the seed. On pressure, it yields an oily liquid of a bland odour.

As regards the structure of the seeds, they are made of hard, moderately thick external shells, containing a kernel in the proportion of 2 to 3 by weight. The kernel yields 70.5 per cent. of a fat which is known in India as Kon oil, *Kusum* oil, *Paka* oil or Macassar oil.

Chemistry of the oil.—The oil, according to Lewkowitsch, is a yellowish white clear liquid which consists chiefly of the glycerides of lauric, palmitic, arachidic and oleic acids. It also contains small quantities of acetic and butyric acids. *Hydrocyanic acid in small proportions is always found present in the oil.*

Laboratory Experiments.

I. *Physiological experiments.*—

(*a*) An alcoholic extract of two seeds of average-size was introduced into the stomach of a healthy cat.

Within half an hour, the animal vomited and became dull and apathetic. It soon recovered without showing any other untoward symptoms.

(*b*) 30 drops of the *Paka* oil supplied by Dr. S. B. Ghosh were mixed with a small quantity of starch emulsion and introduced into the stomach of a healthy adult cat with an india-rubber tube and syringe at 11-30 A.M. on the 21st August, 1919.

11-40 A.M. The animal which was quite jolly and active, became very dull and then dropped down and lay quite helpless on the floor. There was salivation, and twitchings were noticed all over the body. The pupils were normal. The animal placed its chin on the floor and its breathing became quick and shallow.

11-50 A.M. Had severe tetanic convulsions. The animal appeared to be in extreme agony and passed water. Pupils were dilated, mouth open with the tongue protruding.

12 noon. The animal was lying in a paralysed condition. Dilatation of pupil had passed away. It was getting occasional spasms of the head and of the limbs and passed an involuntary stool of semi-solid consistence. Breathing became laboured and slow.

It remained in a comatose condition until death took place at 2-30 P.M.

Post-mortem examination.—Half an hour after death, the body was opened. There was absence of rigor mortis. The pupils were widely dilated.

The stomach was slightly congested. It contained about a drachm of a glairy brownish fluid mixed with a number of oil globules.

The small and the large intestines were normal. There was a quantity of semi-solid greenish fœcal matter in the lower part of the large intestine.

The liver, the spleen, and the kidneys were congested.

The lungs were also congested.

The heart was empty.

The blood had a peculiar bright red colour, sometimes seen in cases of hydrocyanic acid poisoning.

As the symptoms and the post-mortem appearances in the cat were strongly suggestive of hydrocyanic acid poisoning, the viscera were subjected to distlillation with a small quantity of diluted sulphuric acid and the distillate gave reactions of hydrocyanic acid.

The stomach-contents were separately distilled and reactions of hydrocyanic acid were obtained in the distillate.

These results led us to investigate into the chemical properties of the seeds and the oil.

II. *Chemical experiments.*—

(*a*) The powdered seeds were distilled with dilute sulphuric acid and the distillate gave well-marked reactions of hydrocyanic acid.

(*b*) The oil gave no reactions of free hydrocyanic acid: Its reaction is neutral and it is devoid of any characteristic odour.

The oil was distilled with dilute sulphuric acid; faint reactions of hydrocyanic acid were obtained in the distillate.

(c) The oil was saponified with alcoholic potash, acidified with dilute sulphuric acid and distilled. The distillate gave very marked reactions of hydrocyanic acid.

We made a quantitative estimation of the hydrocyanic acid present in the oil, which was found to be 0.3 per cent. as against 0.08 per cent. *i.e.*, 10 times more than what has been recorded by previous observers.

(*d*) A drop of the oil taken in a test tube, shaken with alcoholic potash and heated, and a few drops of a solution of sulphate of iron and ferric chloride added to the mixture, turned deep blue (Prussian blue) when acidified with dilute hydrochloric acid. This test is quite good for detecting the presence of *Paka* oil in adulterated mustard oil; even when it is present in small proportions, a greenish-blue colour is obtained instead of the deep blue precipitate.

The *Reichert-Wollny value* of the oil was determined by us and it was found to be 21 c.c. N/10 NaOH (average of two experiments). The oil, therefore, contains a fairly large amount of volatile fatty acids (butyric and acetic).

The *butyro-refractometer value* of the oil at 40 deg. C. was found to be 51.

Composition of mustard oil.—The mustard plant belongs to the natural order Cruciferæ.

There are several varieties of mustard seed, black, white, red, etc. Besides the fixed oil, which is obtained by pressing the seeds and which is largely used in Bengal as an article of food, a kind of volatile oil is obtainable from the pressed oil-cakes, produced by the action of the ferment myrosin on the glucoside called sinigrin (potassium myronate) present in the seeds. It consists almost entirely of allyl iso-thiocyanate with traces of allyl cyanide. This volatile essential oil of mustard possesses an intensely pungent odour and to it the blistering property of mustard is due. This oil is not ordinarily present in the expressed mustard oil. The fixed oil contains arachidic acid, erucic acid and a liquid fatty acid called rapic acid.

The fixed oil which is used as food contains neither hydrocyanic acid nor any cyanide. Several samples of pure mustard oil were tested for hydrocyanic acid by us by similar methods as in the case of *Paka* oil and all gave negative results. The samples obtained from the Jail Depot of Calcutta and from the Purulia Jail were found to give entirely negative results.

The Reichert-Wollny value of pure mustard oil was found to be practically nil (0.3 to 0.8 c.c.), and its refractive index as determined by the Butyro-refractometer at 40 deg. C. was found to be 59-60.

Analysis of adulterated mustard oil.—We had opportunities of examining five samples of

mustard oil from Calcutta and Howrah, suspected to have caused poisonous symptom. Three of these were forwarded by the police in connection with a case of illness occurring in the family of a Presidency Magistrate of Calcutta, one of which was actually used by the family and two seized by the police from the shop which supplied the oil to the family. The other two samples were sent to us by Dr. Satya Saran Mitra, obtained from families residing at Sibpur, showing poisonous symptoms after their use. The table in the next page shows the results of analysis of these samples and also those of pure mustard oil and the *Paka* oil.

Remarks.—It will be seen from the table that four out of the five samples of mustard oil received for analysis in connection with cases of reported illness were found to be adulterated with *Paka* oil and no doubt these, containing small quantities of hydrocyanic acid, produced symptoms of illness. The results of analysis of the two samples, one of which produced illness in the Magistrate's family and the other seized from the shop which supplied the family with the oil, are identically similar and would leave no trace of doubt in any one's mind that *Paka* oil is being used as an adulterant of mustard oil, and this adulterated mustard oil is responsible for the causation of symptoms noticed in the persons using the same.

It has come to our notice that large stocks of these seeds are to be found in many of the oil-

TABLE.

SAMPLE.	Hydrocyanic Acid.	Reichert-Wollny Value.	Butyro-refractometer Value at 40°C.	REMARKS.
Pure Mustard Oil ..	Nil.	Practically nil	59	
Paka Oil ..	0.3 per cent.	22 c.c.N/10NaOH	51	
Police Mustard Oil No. I ..	Well marked re-actions.	84 ,,	54	Used in the Presidency Magistrate's house causing illness.
Police Mustard Oil No. II ..	Do.	Do.	54	Seized from the shop which supplied the above oil.
Police Mustard Oil No. III ..	Nil.	Nil.	59	
Howrah Mustard Oil No. I ..	Well marked re-actions.	8.5 c.c.N/10NaOH	54	Forwarded by Dr. Satya Saran Mitra as producing illness in a family.
Howrah Mustard Oil No. II ..	Do.	9 c.c. ,,	54	

mills in the town and its suburbs. The mill-owners, when questioned about their presence in the mills, explain that the oil extracted from these seeds is being used for illuminating purposes. The fact that samples of mustard oil obtained from the bazar contain the *Paka* oil is a strong presumption that the seeds found in the oil-mills are being mixed with mustard seeds and the oil expressed from this mixture is being sold in the market as the edible mustard oil.

From the table of analysis, it will be noticed that there is a good deal of difference in the composition of mustard oil and *Paka* oil. Hydrocyanic acid, probably derived from some form of cyanide glucosides, and the volatile fatty acids (butyric and acetic), which are altogether absent in mustard oil, are present in marked proportions in the *Paka* oil. The detection of these (hydrocyanic acid and the volatile fatty acids) in samples of mustard oil undoubtedly proves their adulteration with *Paka* oil. The lowering of the refractive index below 59 (that of pure mustard oil) would corroborate such adulteration.

Action of hydrocyanic acid on animals.—The symptoms produced by hydrocyanic acid in a dog, as described in Blythe's book on "Poisons," are as follows:—

Evident giddiness and distress, tongue protruded, breath taken in short, hurried gasps, salivation, convulsions rapidly set in, passing into paralysis, and insensibility. Involuntary

expulsion of urine and fæces often precede death.

These symptoms were observed in the cat experimented upon with the *Paka* oil in our laboratory.

Hydrocyanic acid paralyses both the brain and the spinal cord. causing insensibility and loss of muscular power. Death from large doses occurs rapidly by syncope due to arrest of the heart's action, or from smaller doses, less rapidly, by asphyxia due to paralysis of respiration.

Although vomiting and purging are not the usual symptoms of hydrocyanic acid poisoning in man, cases are on record where its use in small doses has been followed by nausea, vomiting and looseness of bowels. The gastric symptoms might be due to local irritation in cases where the narcotic symptoms are not so well marked. Nausea and vomiting may also be due to the centric action of the poison. In the case of Dr. S. Mookerjee, who felt very bad after taking his meal in which he used bazar mustard oil, he reported that he felt so giddy and faint that he was unable to get down to his laboratory from his car, but went back home and lay down quietly for a few hours before he completely recovered. His wife who took the same oil, also suffered badly and vomited several times.

The presence of hydrocyanic acid in certain vegetable products is no new discovery. A few plants contain cyanides and many contain amygdalin (which is a glucoside) or bodies formed of the type of amygdalin. In the presence of

emulsin, a ferment, or similar principles and water, these glucosides break up into hydrocyanic acid, grape sugar and other compounds.

Dunstan and Henry have discovered three such glucosides :—

(1) Dhurin in the young plants of the great millet (Sorghum vulgare. *makai*, *bhutta* or *janar*).

(2) Lotusin in Lotus arabicus; a legume indigenous to Egypt.

(3) Phaseolunatin in the leaves of the wild Phaseolus lunatus.

The following is a record of poisoning by the beans of Phaseolus lunatus (Kratok) described by Blythe :—

"In March, 1905, a steamer brought to Rotterdam a cargo of Kratok beans for the purpose of feeding cattle. A workman, employed in unloading, took some of the beans and gave some to a family. The workman ate some boiled beans. A few hours after, he felt unwell, became faint, had convulsions and died about 11 hours after the meal. The family, 6 in number (4 children and 2 adults), partook of the beans. All became ill three hours afterwards. Three of the children died; the rest recovered. The three children who died had no diarrhœa; those who recovered had diarrhœa. Hydrocyanic acid was detected in large quantities in the unboiled beans. From the boiled beans, only traces could be obtained. Hydrocyanic

acid was also detected in the viscera of the three children."

According to Lyon, the following plants with many others all yield, by appropriate treatment, more or less hydrocyanic acid :—

(1) Bitter (but not sweet) almonds ;
(2) Apple and pear pips ;
(3) Plum ;
(4) Damson ;
(5) Cherry ;
(6) Peach ;
(7) Apricots ;
(8) Quince kernel ;
(9) Loquat seeds ;
(10) Root of Jatropha Manihot (Cassava arrowroot) in which hydrocyanic acid is present ready formed.

Some years ago, we had to deal with a case of cattle-poisoning in which the history was that some cattle after eating some grass took ill and died. The sample of grass was forwarded for analysis and we detected hydrocyanic acid in the distillate obtained from the grass.

We have been receiving samples of suspected mustard oil and *Paka* seeds from various mofussil towns in Bengal and Bihar, reporting similar cases of illness following the use of such oil.

From the Civil Surgeon of Purulia, we received 12 samples of adulterated mustard oil,

in 8 of which we detected *Paka* oil. He also sent us a sample of oil expressed in his presence from *Kusum* seeds, which was found to be identical with *Paka* oil.

We received three samples of mustard oil from Ranchi, one more sample from Purulia and one sample from Jalpaiguri, all said to have caused symptoms of poisoning as described above. *Paka* oil was detected in all the samples.

The Sub-Assistant Surgeon of Padampur, in the district of Sambalpur, sent us two samples of *ghee* for examination in September last. The history of the case was that a local zemindar fed about 700 men with *poorees* and sweetmeats prepared with this *ghee*. Almost all the men suffered severely from headache, giddiness, vomiting and purging shortly after taking the food. Both the samples of *ghee* were found to contain *Paka* oil. This shows that *Paka* oil is also being used for adultering *ghee*.

The form in which hydrocyanic acid is present in the oil is engaging our attention, and we hope to present the result of our investigation at some future date.

In conclusion, we beg to express our thanks to Dr. Hiralal Sinha, B.A., L.M.S., for helping us in the investigation, and to Dr. Satya Saran Mitra and Dr. Sasi Bhusan Ghosh, M.B., for supplying us with seeds and oil for our experiments.

IV

INDUSTRIAL CHEMISTRY.

The History and Chemistry of Paper-making.*

CHAPTER I.

HISTORY OF PAPER-MAKING.

(1) *Present Scarcity of Paper.*

There has never been, within the memory of the oldest living person, the incidence of such a world-wide paper-famine as it is our misfortune to suffer from at the present moment. The terrible European War has not only made us feel acutely the pinch in respect of the every-day necessities of life but it has also considerably crippled our intellectual progress by making paper almost a rare commodity.

People all over the world are trying their best to ensure an increased supply of paper. India should not lag behind to participate in this world-wide movement. She should take her turn to employ her capital, her intellect,

* Being a course of lectures delivered at the Indian Association for the Cultivation of Science, Calcutta, in 1920.

her energy and her vast natural resources towards the solution of this difficult problem. And this is my excuse for taking up this important subject in the course of my lectures on Industrial Chemistry this year.

India abounds in suitable raw materials which are used in the manufacture of paper. The art of paper-making, although in a somewhat crude form, has been in existence in this country for nearly 2,400 years, and probably to India, as I shall show later on, belongs the credit of the invention of paper. The improved method of paper-making on modern lines has been introduced into India within the last 60 or 70 years, but the out-put falls far too short of her actual requirements. More than half the quantity of paper required for India is imported from Great Britain and other countries.

In Europe, wood-pulp is now-a-days extensively used for the manufacture of paper and most of the *pulp-wood* is sent out from Scandinavia which practically commands the monopoly of this supply. The following extract from a statement which recently appeared in an English paper, will show the dependence of England on Scandinavia for the supply of raw material for paper-making, and unless she could find some new source of supply within her own dominions, there is little chance of her getting paper cheaper and in sufficient quantity

within the near future. The statement runs as follows :—

"The further the pulp-wood question is investigated, the gloomier is the situation revealed. Last November (1919), the price per ton in Scandinavia of mechanical pulp was 120 *kronen* (Scandinavian money). Today it is 300. So far as can be discovered, there is nothing to prevent the Scandinavian Association that virtually controls the market, from raising the price to 600, or even to 900 *kronen*, unless something is done quickly to take the monopoly out of their hands. Meanwhile, the profits made by the exporters are vast and growing, and the position of the importer becomes steadily more difficult, and the situation in the paper-trade at home more and more acute".

"An analysis of the Board of Trade returns for the past four months shows that the average price for mechanical pulp has risen in the course of six years from about £4-10s per ton to £24 per ton, and for higher grade pure sulphites (a chemical used in the manufacture) from £10 to between £50 and £60 per ton. Seeing that the cost of all other raw materials and chemicals is double or treble what it was, and workers' wages are, reckoned according to the time worked, more than double, it is little wonder that pure white printing at 2d. per lb., the rate at which we used to get it before the European War, are things of the past and likely to be so long as this generation lasts".

"Not until the supply of mechanical pulp-wood is enormously increased will the position in the paper-trade become easier, and the view held in the trade is that, that can be accomplished only by the consumer building his own mills and producing the pulp himself."

The writer suggests the tapping of the forests of Canada for the supply of wood for making paper-pulp. He says—"Only a fraction of the resources of Canada has been tapped yet. The vast region lying between Hamilton Inlet and Lake St. John holds a supply of the right sort of timber waiting only to be used, and sufficient to supply the requirements of the country for years to come."

The "Indian Industries and Power", in a recent issue, observes that "the paper-shortage in the world is very real and genuine. The sooner India takes up the manufacture of paper on a large scale, the better for the printing and publishing trade of Hindustan. The House of Tata might have floated a large concern for the manufacture of paper from the vast raw materials available in India; they are in such a favourable position to supply power and water that the scheme would have appealed, we feel sure, to the whole of industrial India in a highly satisfactory manner."

Must we sit down quietly in India leaving untapped her forests which possess an inexhaustible supply of raw materials of various kinds for the manufacture of paper?

(2) *Substitutes for Paper before its Invention.*

Of all the agencies which have contributed to the progress of civilisation and to the intellectual advancement of man, the *printing press* has played a most important part, but it could have done nothing without the invention of paper.

Before the invention of paper, other material such as stone, bricks, earthenware, metal plates, ivory, wood, chips of bamboo, leather, silken fabrics, barks and leaves of trees etc., were used for recording the edicts of kings, codes of law, for writing scared books, mandates of priests, notes and pictures of memorable events in the reigns of kings, descriptions of battles and deeds of gifts by our ancestors in different parts of the world. Such records are to be found on the walls of the pyramids in Egypt, on bricks, metal plates, on the tombstones in Chaldea and on pieces of wood and earthenware vessels which have from time to time been unearthed during excavation of the ruins of many of the celebrated ancient cities of the world.

STONE AND BRICK.—In Chaldea, for instance, we find records of astronomical observations engraved on bricks and stones that have been dug out of the ruins there. Edicts of Asoka engraved on the sides of hills and on stone-pillars are to be found widely distributed all over India. Stone-inscriptions have been discovered in India whose origin has been traced

to an age far beyond the Buddhistic period. Those discovered at Hurrup in the Punjab and at Giribraja in Bihar, which have not yet been correctly deciphered, are believed to belong to an age preceding that of the edicts of Asoka, although the latter constitute the first authentic historical record of stone-inscriptions in India.

METAL.—The ancients made great use of the metals, then known to them, for recording laws, royal proclamations and important public events. In Italy, lead sheets were largely used for this purpose. The works of Hesiod were inscribed on a table made of sheets of lead. The Laws of the 12 Tables of Rome were engraved on a brass plate. It is said that about three thousand brass plates bearing inscriptions were destroyed by a disastrous fire that broke out in the reign of Emperor Vespasian. Dr. Buchanan has discovered six engraved plates of mixed metal in an ancient monastery in Syria. Copper-plates have been found in many places in India bearing inscriptions of royal orders, geneology and history of the dynasties of kings, records of war and deeds of gift. The iron pillar in old Delhi bear writings in Brahmee character which date back a few centuries before the Christian era.

WOOD AND IVORY.—Boards made of wood have been in use for writing and for engraving from very ancient times. Boards of convenient size were bound up together in the form of books

and these went by the name of *Codex.* The Laws of Solon were recorded and preserved on wooden boards, and some on stones also. Ivory was also used in Greece for a similar purpose. Pieces of wood bearing inscriptions are still to be found in large numbers in China, Japan and Burma where ivory was also used for engraved writing.

Leather and Parchment.—From a very early age, leather has been in use as a substitute for paper. It is stated that the Gospel of St. Mark was first written on sheep's skin, and long before this, the two celebrated Greek epics, Illiad and Odessy, were recorded on the soft skin of the abdomen of a certain species of snake. Parchments made of animal skins were in general use in the courts of kings for recording laws and royal orders: the best and finest parchment was known by the name of "Vellum".

Silk.—We find it recorded by Pliny that writing was done by the ancients on silken cloth also.

Bark.—The ancient Chaldeans used the barks of certain trees for writing purposes. Such barks were called *Leber* by which term we now understand books. The bark of the *papyrus* tree was used from very early times in Egypt as a substitute for paper which derives its name from the Egyptian word *papyri* which was the prepared bark used for writing. Several thin

pieces of the bark were pasted together by rubbing a little water on the edges which would make them sticky, and large sheets suitable for writing were thus obtained. There were two kinds of *papyri* made in Egypt; the best one was called by the Greeks the *Heretica* which was used for writing sacred books and State orders. The secret of making *papyri* was long confined to the Egyptian priests, but the Romans and the Greeks subsequently managed to learn the art and began to manufacture *papyri* in their own countries. Some of these were named after the names of the Roman Emperors and Empresses.

In India, barks of trees have long been used for writing purposes. The bark of the India Birch (Betula Utilis) which grows in the Himalayas, commonly known as the *Bhurja-patra*, is still to be seen. *Mantras* (incantations) written on bits of *Bhurja-patra* and enclosed in metal cases are still worn as talisman as a protection against the influence of evil spirits, against witch-craft or as cure for intractable diseases. The Indian birch bark is well-suited for writing purposes; such writing is not easily effaced. The bark, however, is very fragile, and when old, goes to pieces unless very carefully handled. The oldest writing on *Bhurja-patra* preserved in India is said to be not more than 300 years old, but bark-manuscripts of the 3rd or 4th century A.D. have been discovered and preserved.

Certain aboriginal tribes of Assam still use the bark of Aguru tree (Aquilaria Agallocha) as a natural paper. Sir Edward Gait, the present Lt. Governor of Bihar and Orissa, was the Director of Land Records and Agriculture in Assam in 1894. In a paper communicated by him to the Asiatic Society of Bengal, he stated that the Aguru bark was widely used as a writing material throughout Assam prior to the introduction of paper; its employment as such seemed to have escaped notice. Mill-made paper is still regarded by the priests in certain parts of Assam as impure for purposes of religious ceremonies and sacred writings and the Aguru bark is used instead. The bark is sometimes used as covers for binding books.

In Sumatra and Java, a kind of bark is still used by the natives as a substitute for paper.

LEAF.—Palm leaves have long been in use in India for writing purposes; Sanskrit and Bengalee manuscripts are to be seen in private houses and preserved in libraries and museums written on palm leaves. The oldest palm leaf manuscript discovered in Nepal belongs to the 10th century A.D. The leaves of the two species of Palm, Corypha Umbraculifera and Borassus Flabellifer, were mostly used. The writing was done by scratches being made with a sharp iron needle and these were subsequently loaded with powdered charcoal or other kinds of pigment. Writing was also done by means of a

specially prepared ink. *Theret* (তেরেট) leaves (a variety of palm) were likewise used in India for the same purpose.

(3) *First paper made in India from Cotton-Wool.*

The art of making paper from vegetable fibres, such as cotton-wool, was known to the Indian and the Chinese from a very early time. When Confucius lived in China, thin strips of bamboo were used there as writing material in place of paper; the writing was made by scratching these pieces with a sharp style. It appears that the Chinese learnt the art of paper-making in the early part of the second century A.D.; some authorities fix the period at 105 A.D. The Chinese had even a paper currency as early as the 7th or 8th century A.D. European authorities generally give to the Chinese the credit of invention of paper. They maintain that there is no satisfactory evidence to show that the art of paper-making was known in India before the 14th or 15th century A.D. But this statement should be accepted with a certain amount of reserve. Babu Nagendra Nath Basu Prachya-Vidyamaharnaya in his celebrated Bengali Encyclopœdia known as the *Vishwakosha* states on good authority that when Alexander the Great invaded India in 327 B.C., his general Nearchus found a kind of thin, fine, glazed sheets (which were made by felting cotton-wool) used for writing in the Punjab and this fact he has recorded in his writing. Evidently,

this was some kind of paper but how it was manufactured was not described. This record by a Greek historian who visited India more than three centuries before the birth of Christ is strong evidence in favour of the existence of the knowledge of paper-making and of the use of paper in India long before the Chinese came to know of it. The credit of the invention of paper and of its use as a writing material, therefore, rightly belongs to India in the light of the information we at present possess.

(4) *Paper-making in Asia.*

The Arabs appear to have learnt the art of paper-making from the Chinese. They founded a paper-manufactory at Samarkand in 705 A.D. In the middle ages, Damascus was famous for the manufacture of paper. The paper made in Damascus was known as "Charta Damascena"; it earned a far-reaching celebrity and obtained access to all countries in the East and the West. The oldest Arab manuscript on paper which is to be seen in the library of the Leyden University is dated 866 A.D.

The kind of hand-made paper made in India from cotton fibres, goes by the name *Tulat* (तूलात from Tula—cotton-wool). At one time, all sacred writings, manuscripts, documents, and accounts were used to be in such paper. There were two kinds of *tulat* paper made in India, the white and the yellow, preference

being given to the latter. In later days (about 3 to 4 hundred years ago), such paper was largely manufactured at Maldah in Bengal. The manufacturers of paper were principally Mahomedans and they formed a separate community known as the *Kagjees*. They made the pulp for paper by boiling waste paper and old cotton rags with *sajimati* (impure Carbonate of Soda) and lime, mixed it with rice-starch, spread the pulp in thin layers of required size on perforated wooden trays made specially for the purpose, and got them dried by the sun's rays. At one time, the trade in hand-made paper was in a flourishing condition in Bengal. It was exported to various places outside Bengal, and it is said, outside India also. The paper was strong, durable and did not soak.

Besides Maldah, hand-made paper was also manufactured on a smaller scale at Maiman in the district of Hooghly, in Dacca, Shahabad, Muzafferpur, Aurangabad, Doulatabad, Ahmedabad, Dharwar and Kolapur. The Aurangabad paper was considered to be the best of the lot. In Doulatabad, a special kind of paper was manufactured which was beautifully decorated by mixing fine gold leaf with the pulp. This ornamental paper was called *Afsani* and was much in demand in the courts of Indian princes for State-purposes.

Purely hand-made paper is still being manufactured in India, Burma, China and Japan. The Chinese use almost any and every

kind of fibre for the manufacture of paper. They were the first to make paper from silk. They prepare a kind of paper called *Ho-si* from straw which they use in place of firewood for burning dead bodies. Another paper called *Pis-Je* is made in China from the fibres of the mulberry tree and is used as a substitute for lint in surgical dressings. *Hoa-sien*, *Tase*, *Chang-se*, *Mapi-en*, *Lien-se* are the names of other kinds of paper made in China; some of these are used for packing purposes, others for writing and printing as art-paper. The Chinese prepare another kind of paper called Lasi-en, which is used as a substitute for wax-cloth. "India-paper" was considered to be the best of all paper made in China for printing and drawing purposes. The Chinese prepare a kind of glue from fish-bones which they largely use for sizing and glazing paper.

The art of paper-making was long known in Thibet. It was generally made there from the fibres of the Daphne plant. Thibet paper at one time was exported into other countries.

The Japanese use mulberry fibres as well as those of Papyvera Sativa for the manufacture of handmade paper which they stiffen and glaze with rice-starch. The Japanese are great adepts in the preparation of handmade paper which they use not only for writing and printing purposes but also for the manufacture of a large number of articles in every-day use. Their furnitures are sometimes made of thick boards made of

paper, and they make handkerchiefs, towels, shirts, head-gears, fans and umbrellas from papers of different strength and thickness. Paper is also used in Japan for making toys, for roofing and walling their dwelling houses, and for making wheels for carriages.

In Burma, a kind of writing slab (Parabaik) is made by pasting together several pieces of native hand-made paper painted black with charcoal. Soapstone is generally used for writing on these slabs. The Burmese also prepare a kind of water-proof paper for making their umbrellas.

In Nepal, hand-made paper is made from bamboo fibres as well as from the fibres of Daphue Cannabina. The Nepalese use wood-ash for making the pulp. Nepal paper is largely used for packing purposes. The paper is glazed by being rubbed hard with shells.

In Bhuttan, the native hand-made paper is made from the fibres of *rhea*.

At one time, Kashmir was famous for the manufacture of paper of excellent quality. The Kashmir papers were largely used in the courts of the Moghul Emperors. Rags and hemp-fibres are used in Kashmir for making paper. It is believed that the art of paper-making was introduced into Kashmir from Samarkand.

Stein, during his recent excavation of Niya and other sites in Central Asia, has discovered many documents and letters which seemed to have belonged to the ancient state of Khotan.

The materials used were specially prepared strips of wood, pieces of leather, various kinds of papers and also birch bark (*Bhurja-patra*). It appears that during the latter part of the 3rd century A.D., paper found its way to Khotan from China which then held domination over this state in Central Asia. The papers discovered in the Khotan ruins have been examined and found to be made of Daphne fibres which are still used in large quantity in Thibet for paper-making. It is, therefore, surmised that paper found its way to Khotan from Thibet also in the early part of the Christian era.

The oldest Persian paper-documents found by Stein date from 718 A.D.

The earliest European record of the use of paper in India (save that made by Nearchus) is by Nicolo Conti who visited India in the early part of the 15th century and found the people of Cambay using a kind of paper for writing purposes. Abd-er-Razzak, who came to India in 1442 A.D., visited Vijaya-nagar which he described as "the capital of the mightiest kingdom on Earth" and he found the people of the place writing both on leaf, and on a kind of paper with blackened surfaces by means of a soft white stone.

The so-called "Serampore paper" was at one time used all over India. It owes its name to the paper-mill which was started in that city in the first half of the 19th century and which is believed to be the pioneer of paper-mills in

Bengal. The actual date of the starting of this mill is not known, but Mr. Trail saw some of the rusty remains of this mill in Serampore during his visit there in 1864.

Before 1840, a large supply of paper for India was obtained from China. From that year, the trade in hand-made paper began to flourish and factories were started all over India. But it received a severe check during Sir Charles Wood's tenure of office as Secretary of State for India who passed an order that all the supplies of paper used by the Government of India, should be purchased in Britain. This short-sighted and ill-considered policy dealt a heavy blow to the indigenous industry which began to decline from that time and the loss is to be regretted on considerations of both economy and art.

(5) *Paper-making in Europe.*

Paper seems to have come into use in Europe in the 12th century A.D. The Moors had their factory at Valencia in Spain from which they supplied paper to other European countries. The oldest manusctipt on paper in Europe is dated 1102 A.D.

The manufacture of paper in England does not go back earlier than the 16th century when an Englishman named Tait founded a paper manufactory at Hartford. He was followed by Spielman, a German, who established a factory for making paper at Dartford in 1558 A.D. Even in 1690, only coarse brown paper

was made in England and all fine paper was imported from France and Holland. In 1770, good thin writing paper was first made in Kent. Up to 1801, all English paper was hand-made.

In 1798, Louis Robert, an employee in a paper-manufactory located near Paris, first invented a machine for making paper. In 1804, a firm named Fourdrinier & Co., started making machine-made paper in England which, at that time, was their monopoly. Their business, however, failed, but some of the members of the Fourdrinier family succeeded in obtaining a pension from the State.

Machine for making paper was first introduced into America in 1820.

Now-a-days, most paper in use all over the world is machine-made. In the manufacture of the so-called *hand-made* paper of Europe, many of the processes are done by machine.

(6) *Materials for Paper-making.*

Paper is made from cellulose which is obtained from all kinds of vegetable fibres forming the frame-work of tissues of plants. These fibres are separated, purified and reduced to the condition of pulp by mechanical and chemical means. The pulp is then bleached, loaded, sized, floated in water, allowed to settle over a wire-mould and the water drained off. Paper is thus formed by the *felting* of the fibres contained in the pulp. It is subsequently

pressed, dried and glazed, cut into required sizes and baled.

A very large number of vegetable fibres are used for making paper. Old cotton and linen rags which practically consist of pure cellulose, were at one time almost exclusively used for this purpose. Their use has in recent years been to a great extent limited, their place being taken up by certain kinds of grass and wood which are much cheaper. Old cotton rags form excellent material for paper-making. There are traders whose business is to collect rags and send them to manufactories where they are turned into paper.

Substances of animal origin such as wool, silk and skin, and mineral substances such as asbestos, have also been used for making certain kinds of paper.

Besides cotton and hemp, there is a large number of other fibres utilised for making paper. The more important among them are the flax, jute, straw, stems of wheat, oat, plantain and sugar-cane plants, many varieties of grass, various kinds of wood, cocoanut fibres and bamboo. Certain kinds of grass (such as the *Esparto* in Europe and the *Sabui* and *Moonj* in India), wood-pulp, straw and rags at present form the principal raw materials for the manufacture of paper.

BAMBOO.—Recently, bamboo has been much extolled as an excellent material for making paper and it deserves a special notice here.

So early as 1875, Mr. Routledge who visited India, wrote in his valuable monograph on "Bamboo as a paper-making material" that—"of all the fibre-yielding plants known to Botanical science, there is not one so well-calculated to meet the pressing requirements of the paper-trade as bamboo, both as regards facility and economy of production, as well as the quantity of the "paper-stock" which can be manufactured therefrom. Grown under favourable conditions of climate and soil, there is no plant which will give so heavy a crop of available fibre to the acre, no plant which requires so little care for its cultivation and continuous production."

There are, however, certain practical difficulties regarding the employment of bamboo for paper-making which were not anticipated at the time when Mr. Routledge made the above observations. In the first place, the young shoots only of bamboo are suitable as raw material for paper, the older stems being too hard for this purpose. It is, however, always difficult to obtain a sufficient number of young shoots, because when these are wholly removed, the parent plants suffer severely, their growth becomes stunted and they are ultimately killed. Hence methodical working of bamboo jungles becomes essential, and that means considerable increase in the charges of collection and transport. Sir George King, as the result of his experiments, has noted that if all shoots are removed during three successive years, the

bamboo plant is killed. Then there is the difficulty of getting labour to work bamboo jungles during the rains when the young shoots come out, and the freight and transport charges are calculated to be very heavy. Moreover, the hairs of scales and young leaves of bamboo are considered as drawbacks to its employment for making paper. It has also been found that a larger quantity of chemicals is needed to make pulp from bamboo fibres than in the case of other fibres ordinarily used for making paper.

In spite of these difficulties, Mr. Hill has given a favourable opinion regarding the employment of bamboo as a paper-material. He wrote thus in 1905 :—

"It is considered that the manufacture of paper-pulp (from bamboo) would be practicable from a commercial point of view ; the prospects of an export trade for unbleached bamboo-pulp appear to be favourable, having regard to the excellent quality of the pulp prepared under favourable conditions. It is estimated that a ton of unbleached bamboo-pulp could be produced for £5-10s including manufacturing costs, interest and miscellaneous charges. The cost, supplemented by the freight to England and sundry dues, would be increased to £7-10s as the price delivered to London or Liverpool. Considering the quality of the pulp, a profit should be realised, since wood-pulp is valued at £8 to £9 a ton."

Now, this was written in 1905. The price of wood-pulp in Europe, has since gone up enormously, specially after the War, and it is now about £24 per ton and is likely to rise to a much higher figure. Bamboo has, therefore, a much better chance now as a cheap material for making paper of much higher quality than could be obtained from wood-pulp.

Other experts have also thought very favourably of bamboo. The late Sir Dietrich Brandis seemed to think that in spite of all the disadvantages, "bamboo has a future in India." He urged the necessity for a thorough enquiry into whether or not, by special cultivation, the plant could be induced to afford shoots more freely and for a longer period, without injury to the rhizome, and whether it would not be possible for mature culms to be used in the paper-making."

Recent experiments have gone a great way to fulfil the expectations of Sir Dietrich Brandis and it is hoped that this inexhaustible natural product of India would be fully utilised to meet not only all her own requirements of paper but raise her to the position of a supplier of first-class paper-material to countries beyond her shores.

OTHER INDIGENOUS PLANTS.—I shall now very briefly refer to a list of the more important plants other than cotton and bamboo,

which are indigenous and which yield suitable fibres in good quantity for paper-making.

(1) Agave or the American Aloe plant—It was originally an American plant. Many species now grow extensively in India; the leaves and roots yield good fibres for paper-making.

(2) Antiaris Toxicaria (the Upas tree of Java)—It is a poisonous tree and grows in South India and Ceylon. The tree yields good fibres for paper.

(3) Broussonetia Papyrifera (Burmese—Malaing)—It grows in Burma and is used for fencing gardens. Both the Japanese and the Chinese prepare a large quantity of paper from the fibres of this plant.

(4) Corchorus Oliotorus and Corchorus Capsularis (Bengali—*Pat*—Jute)—The cuttings are largely used in India and in Europe for making brown paper.

(5) Crotolaria Juncea (Hemp; Bengali—*San*)—It is used for making paper on a small scale. It is rather an expensive material for paper-making. Generally, old ropes and nets made of this fibre are utilised for making paper.

(6) Daphne Payracea and Daphne Longifolia (Hindi, Svet Barooa; Nepalese—Mohadeo-ki phool)—It grows in the Himalayas. Stiff and durable paper is made from the fibres of both the species in Nepal, Bhutan and Thibet.

(7) Edgeworthia Gardeneria (Nepalese, *Arili* or *Kaguli*)—The plant grows wild in Manipur,

in Burma and in the Himalayas. The best Nepalese paper is made from its fibres.

(8) Hibiscus Isora (Bengali—Antmorha)—The plant is found in Central and Western India. The fruits are used in Ayurvedic medicine. The fibres are used for making ropes and sacks. In the Dacca district, the fibres are used for making hand-made paper.

(9) Hibiscus Cannabinus (Bengali, *Mesta-pat*)—It is found wild in the Eastern and Western Ghauts and also in the United Provinces and in the Punjab. The fibres are used for making ropes. In the Madras Presidency as well as in Dacca, a kind of hand-made paper is manufactured from the fibres of this plant.

(10) Ischæmium Angustifolium (Hindi—*Sabui* or *Bhabar*; Bengali—*Babui*).—This grass grows in abudance in Bengal, in the U. P., in the Central Provinces and in the Madras Presidency. It is an excellent material for paper-making and is stated to be in no way inferior to esparto grass which is so extensively used n England for the manufacture of the best varieties of paper. In the Bengal paper-mills, sabui is very largely used, either alone or mixed with rags, for paper-making.

(11) Musa Sapientum (Bengali—*Kala*, plantain tree).—Paper of good quality may be made from the fibres of plantain tree which grows in abundance in all parts of India. The ash of plaintain tree contains a good quantity

of alkali and is largely used in India for washing clothes in place of washing soda.

(12) Opuntia Dillenii (Bengali—*Phani Mansa*).—It grows wild in this country, specially in sea-coast places. Its fibres may be utilised for making paper.

(13) Saccharum Sara (Bengali, *Sar*; Hindi, *Moonj*)—This grass grows in Bengal and in the U. P. In Oudh, a kind of hand-made paper is made from its fibres. The fibres are considered as good as the *sabui* grass and largely used in the paper-mills in India.

(14) Sausevieria Zeylanica (Bengali, *Moorga* or *Moorgavi*).—It grows wild in sea-coast places in Bengal and in Madras. The fibres form a good material for paper.

(15) Yucca Gloriosa (Adam's needle)—It is an American plant which is cultivated in the Madras Presidency. Paper of good quality may be made from its fibres.

These are some of the more important plants mentioned by Sir George Watt, the fibres of which are either being used or may be utilised for the purpose of manufacturing paper in India.

(7) *Mill-made Paper in India.*

The following account of the paper-mills in India furnished by the Director of Statistics, Government of India, in his report (1919),

is of sufficient interest to warrant quotation here :—

"The number of paper-mills in India in 1917 was ten, four in the Bombay Presidency, three in Bengal, one in the United Provinces, one in the Travancore State, and one in the Gwalior State. The estimated authorised capital of these mills, as far as information is available, was about 52½ lakhs. The value of the output reported rose from Rs. 125 lakhs in 1916 to Rs. 188 lakhs in 1917 and was the highest on record."

"In 1913, the value of paper manufactured in India and that of import paper were Rs. 80 lakhs and Rs. 159 lakhs respectively. In 1917, the corresponding figures were Rs. 188 lakhs and Rs. 203 lakhs, the value of the imports having increased in the mean time by 28 per cent, and the internal production by 134 per cent." The values of country-made and imported paper have thus risen from Rs. 80,37,000 and Rs. 1,37,00,000 respectively in 1913 to Rs. 1,59,86,000 and Rs. 2,03,00,000 in 1917. The increase in 1917, both in internal production and in imports, is noticeable."

The Director observes that owing to the war and the resulting absence of competition from the enemy-countries, the Indian paper-industry is comparatively prosperous, notwithstanding the increase in the prices of wood-pulp and chemicals required in the process of

manufacture and the liability to secure new machinery.

The table in the next page compiled from the Statistics of British India, Vol. I. 1919, shows the number of paper-mills in the different provinces of India and the quantity, value and the kind of output produced by these mills :—

TABLE I.

Showing the Statistics of Paper produced in India (Mill-made), 1917.

Name of the Mill and the Province in which it is situated.	Year of establishment.	Production: Quantity in tons.	Production: Value in Rupee.
I. Bengal.			
(1) Titagarh No. I Paper Mills, Titagarh ..	1882	9,339	63,30,000
(2) Titagarh No. II Paper Mills, Kakinara ..	1903	10,2[illegible]4	60,84,000
(3) Bengal Paper Mills, Raneegunj ..	1860	6,600	40,00,000
		26,203	1,63,14,000
II. U. P.			
(4) Upper India Couper Paper Mills, Lucknow ..	1879	3,163	12,31,158
III. Bombay.			
(5) Girgaum Paper Mill, Bombay ..	1802	312	1,74,720
(6) D. Padamjee Paper Mills, Bombay ..	1913	1,145	4,80,900
(7) Mahomedbhai Jamaludin Paper Mills, Surat ..	1878	10	4,596
(8) Reay Paper Mills, Poona ..	1885	540	3,13,087
		2,007	8,73,302
IV. Travancore State.			
(9) Meenakshi Paper Mills, Punalur ..	1914	110	66,000
V. Gawalior State.			
(10) Scindia Paper Mill ..	1903	378	2,01,247
Grand total for whole India ..		31,868	1,87,86,707

KIND OF PAPER MADE IN THE ABOVE MILLS.—(1) Blotting; white cartridge; E. S. and T. S. writings; coloured printing; *badami*, brown, and fine and deeper calendered printings and pulp-boards.

(2) Do. Do.

(3) Writing, printing *badami*, brown papers, &c.

(4) Brown, *badami*, white printing; cream-laid; coloured; white cartridge and H. B. A. Government, white rough; Government water-marked paper; blotting; red casing, &c.

(5) Casing and top paper.

(6) White printing and writing paper; coloured and brown paper.

(7) Country white paper used for native account-books.

(8) Writing; printing; blotting; brown.

(9) Brown casing paper.

(10) Description of paper not stated.

I have given you a brief outline of the history of paper-making from the very early down to the present times. I propose to deal with the chemistry of paper-making in my next lecture.

I have on the table specimens of inscriptions on stone, brick, bamboo and copper plate, and also of Sanskrit, Arabian and Bengali manuscripts on palm leaves and on various

kinds of hand-made paper made in India, Nepal and Thibet, of different dates, some from five to eight centuries old and others of much later date, for your inspection. The greater portion of these have been kindly lent to me by the Bangiya Sahitya Parishad, and some by the Sahitya Sabha of Calcutta. To them, I offer my grateful thanks.

CHAPTER II.

CELLULOSE AND OTHER MEMBERS OF THE SAME FAMILY.

Cellulose, which is the raw material for all kinds of paper, belongs to a very important class of organic compound known as carbohydrates. They occur in plants naturally in various forms and are composed of three elements only, *viz.*, Carbon, Hydrogen, and Oxygen, the last two being present in the same proportion in which they exist in water,—hence the name carbohydrate (Hydrate of Carbon). The chemical formula of water is H_2O, which means that for every two atoms of Hydrogen in the molecule of water, there is only one atom of Oxygen. The same relation exists between Hydrogen and Oxygen in the composition of the carbohydrates. Take the formula of cane-sugar which is a carbohydrate. The formula is $C_{12}H_{22}O_{11}$. Here we see that the number of Hydrogen atoms in the molecule of cane-sugar are double those of Oxygen.

Carbohydrates, though mostly found in plants, are also found in the animal kingdom. Thus, milk-sugar is found in milk which is an animal fluid, and glycogen in the liver of animals.

The chief carbohydrates of vegetable origin are starch, grape-sugar, cane-sugar, fruit-sugar, cellulose and various kinds of gums. Some of these form an important class of food for man

and herbivorous animals, and others are extensively employed in the arts and industries. For example, cellulose is a substance from which all cloths (except woolen and silken) and papers are made. It is also used in the manufacture of a number of explosive substances. Cellulose forms the chief food of all herbivorous animals. Starch and various kinds of sugar are largely used as food; they are also employed in the production of alcohol and many other important articles of commerce.

Although we are concerned in this lecture with cellulose only, I think it will not be out of place to briefly consider here the properties and industrial uses of some of the more important members of the carbohydrate family.

The carbohydrates may conveniently be put under the following four heads:—

1. Sugars.
2. Starch.
3. Cellulose.
4. Gums.

The members of the first group are more or less sweet to the taste, while those of the other three groups are practically tasteless. To the first group belong cane-sugar, grape-sugar, fruit-sugar, malt-sugar and milk-sugar. The last three groups include the various kinds of starch, cellulose, dextrin, glycogen and various kinds of gums. We shall take up the consideration of the sugars first.

CANE-SUGAR.—It is a most important article of commerce. It is found ready-made in the stems, roots, tubers, fruits and flowers of many plants. In India, it is mostly obtained from sugar-cane but not an inconsiderable quantity is derived from the juice of many varieties of palm, such as the date-palm, cocoanut-palm and palmyra-palm. The sugar from sugar-cane is called the cane-sugar, while that obtained from the various palm juices is generally known as palm-sugar.

In Europe, sugar is almost exclusively obtained from beet-root.

About 16 to 18 per cent. of sugar is present in the juicy stems of sugar-cane. The juice is expressed by crushing the stems in a press, or by cutting them into thin longitudinal slices and macerating them in water at a high temperature in a specially constructed apparatus called the *Diffusion battery*. A much larger quantity of sugar is obtained from the canes by this method than by pressure. The juice is then mixed with milk of lime, boiled and filtered. The filtrate is concentrated and allowed to crystallise in casks with perforated bottoms through which the molasses passes out, or the crystals are separated by a centrifugal machine and these crystals form the brown sugar of commerce. It then undergoes a process of *refining*, as in the case of beet-sugar described below.

It was a German chemist who first extracted sugar from beet-root and he recommended its cultivation in Europe. By careful cultivation, the percentage of sugar in the beet-root has been doubled. Good beet-root contains from 13 to 14 per cent. of sugar. The process of extracting sugar from beet-root is by diffusion, as described under cane-sugar. A much larger quantity of sugar is extracted from the beet by this method. The juice is then mixed with milk of lime and boiled when the acids present are neutralised and the vegetable albuminoids are precipitated. Carbonic acid gas is then passed into the liquid to precipitate the lime. It is then *refined* by boiling with animal charcoal to remove the colouring matter, filtered, evaporated in steam-heated vacuum pans until the syrup is of such consistency as to deposit crystals on cooling. It is then allowed to cool and crystallize. When no more crystals form, the mother-liquor known as the molasses is separated from the crystals by a centrifugal machine. The crystals are then dried.

The molasses was formerly utilised for preparing alcohol by the process of fermentation. It contains a good amount of sugar but it was found extremely difficult to crystallize it, as it contained many impurities. By a recent process in which Strontium hydrate is used instead of lime, it has been possible to get crystallized sugar from molasses, and the process is now being advantageously used for this purpose.

There are certain factories in which brown sugar only is prepared, and the process of *refining* is done in other factories. At one time, a large quantity of brown sugar produced in India used to be exported to Europe, and the process of *refining* carried out there.

The crude method of obtaining sugar from sugar-cane as practised by Indian cultivators is very wasteful. All sugar factories in India under European management employ improved modern methods and machinery for its manufacture and their output is much larger and of a superior quality.

At one time, so much sugar was produced in India that it was not only sufficient to meet her own demands but she was able to export it to other countries in large quantities. She has now to depend largely upon other countries for her supply of sugar. The table below shows the total quantity and value of sugar imported into and exported from Brtish India in 1917-18. The figures have been taken from the *Statistics of British India*, 1919, Vol. I.

Year.	Import.		Export.	
	Quantity in cwt.	Value.	Quantity in cwt.	Value.
		Rs.		Rs.
1917-18	1,02,01,731	15,31,03,151	9,45,674	1,86,54,120

In 1917-18, there were forty sugar-factories in India (including four in the Native States) employing 9,847 men.*

The price of sugar has gone up very high of late and this most coveted and nourishing article of diet is now almost beyond the reach of people of ordinary means. While the sugar-producing capacity of India is on the decline, that of other countries has steadily gone up and a large quantity now comes to India from Java, Mauritius and Europe. Europe now alone produces 16 million tons of sugar annually, which is nearly equal to half the world-production of sugar. I understand that a Sugar Convention has been formed in India with the object

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*The following notes are taken from a paper on Indian Economic Conditions by Sir R. N. Mookerjee, K.C.I.E. K.C.V.O., published in the Asiatic Review :—

"The Indian Sugar Committee of 1921 dealt exhaustively with the sugar position. India has, on the average, about 2¾ million acres under sugarcane cultivation (about half the world's acreage); yet her imports of sugar during the three years 1920-21, 1921-22, 1922-23 were 3,43,891, 7,82,668, 5,04,090 tons costing Rs. 18¾ crores, 27½ crores, and 15¼ crores respectively! India has the largest cane-growing area in the world; yet her production per acre is the lowest, being only 1.07 tons to the acre against 1.96 tons in Cuba, 4.12 tons in Java and 4.61 tons in Hawaii. The chief impediments to the growth of a sugar-refining industry—an industry which one would reasonably expect India to develop first in view of the continuous and large demand of her people for refined sugar—are the poor quality of the crop, the partition of the land into numberless small holdings, the heavy capital expenditure needed for putting up a modern sugar-plant and the very keen competition from Java which supplied 83 per cent. of her imports last year. Although no action on the Report of the Sugar Committee has yet been taken, the value of their broad and comprehensive recommendations should be recognised. They include the organisation of the sugar Industry on the Java model,—a system of State subsidies for research institutes, demonstration farms, and technical schools—all directed and inspired by a sugar-board."—EDITOR.

of devising ways and means for improving and increasing the production of sugar and steps are being taken to extend the cultivation of better class sugar-cane and to employ improved methods of manufacture. I hope India will soon be able to regain her former position as the first sugar-producing country in the world.

In this connection, I am to glad to note that a new Joint Stock Company has been started under the name of "Dehri-on-Sone Sugar Works Ld." with a capital of Rs. 10,00,000 to establish in Bihar an up-to-date Sugar factory and refinery. Dehri-on-Sone is one of the most important centres of sugar-cane cultivation in Bihar. The company proposes to produce white crystal sugar from cane without the use of bone-charcoal, which may thus be used by orthodox Hindoos without any objection.

Cane-sugar is a white crystalline substance readily soluble in water and the solution is very sweet to the taste. If pieces of thread are suspended in the syrup while it is crystallizing, large crystals called *sugar-candy* are formed. Sugar is one of the most important and indispensable articles of our diet; it is the quickest producer of heat and energy.

Cane-sugar turns the plane of polarisation of light to the right. The strength of a solution of sugar may be determined by the amount of rotation it causes in an instrument called the *Saccharimeter*.

Barley-sugar which is used for making lozenges, is obtained by heating cane-sugar with a small quantity of water. On cooling, it sets into a hard glassy mass.

When cane-sugar is heated, it is converted into a dark-brown substance called *caramel* which is largely used to colour confectionery and spirits.

Cane-sugar prevents decay of organic substances and, therefore, acts as an antiseptic. It is largely used as a preservator of food such as condensed milk, jams and jellies and candied fruits.

When a solution of cane-sugar is heated with diluted acids, it is broken up into two entirely different kinds of sugar—the grape-sugar and the fruit-sugar—in equal quantities. The new product is called *invert sugar*. Cane-sugar does not produce a red precipitate when boiled with Fehling's solution but the *invert sugar* and all other kinds of sugar do. This test is, therefore, employed to distinguish cane-sugar from the other varieties of sugar.

Strong sulphuric acid chars cane-sugar even without the application of heat; the whole thing swells up and steam is evolved.

Alcohol cannot be produced from cane-sugar by *direct* fermentation. It must first be converted into grape-sugar by a ferment called *invertase*; it is then acted upon by another ferment called *yeast* and turned into alcohol. Large quantities of spirit are produced from brown sugar and molasses by fermentation.

Cane-sugar may readily be detected by boiling its solution with resorcin and diluted hydrochloric acid in a test tube when a red colour is developed. This is a good test to detect the presence of cane sugar in milk, as sugar is often added to watered milk to raise its specific gravity.

GRAPE-SUGAR. It is also called glucose or dextrose. It is found naturally formed, often associated wtih fruit-sugar, in many fruits, particularly in ripe grapes from which it derives its name. The nectar of flowers, which the bees gather and from which they elaborate honey, contains grape-sugar.

When grapes are dried in the sun in the making of raisins, the grape-sugar is deposited as hard nodules on the surface of the dried fruits.

It may artificially be prepared by boiling starch or cane-sugar with dilute acids and removing the fruit-sugar (which is produced by this process) by dissolving it in alcohol. The artificial grape-sugar is largely used in confectionery, in preserving fruits, in making jams, as a substitute for malt in making beer and in medicine. It is used in the manufacture of wines and spirits. Champagne and brandy are made from the fermented grape-juice.

Grape-sugar is a crystalline substance soluble in water, less sweet than cane-sugar and not readily charred by sulphuric acid. It turns the

plane of polarisation of light to the right, it is, therefore, called *dextrose.*

When boiled with Fehling's solution, it produces a red precipitate.

FRUIT-SUGAR. It is also called *fructose* or *levulose.* It is found in all sweet fruits and honey associated with grape-sugar.

It turns the plane of polarisation of light to the left; it is, therefore, called *levulose.*

It is artificially made in large quantities by boiling *inulin* (a variety of starch from daliah tuber) with diluted sulphuric acid. It is used (as a less harmful food) in diabetes in place of cane-sugar.

It is crystalline and soluble in water. It undergoes fermentation by yeast, producing alcohol.

It produces a red coloured precipitate when boiled with Fehling's solution.

MILK-SUGAR. It is also called *lactose.* It is present in the milk of all mammals in different proportions. It may be obtained from milk by throwing down the protein by the addition of *rennet* or any acid, evaporationg the liquid and re-crystallizing the residue in water.

It is much less sweet than cane-sugar. It forms large hard crystals. When boiled with Fehling's solution, it throws down a red precipitate.

Certain bacteria cause fermentation of milk-sugar, turning it into lactic and butyric acids

which curdle the milk. By fermentation of milk-sugar, alcohol is also produced.

A kind of alcoholic drink called *koumiss*, is prepared in Russia by the fermentation of mare's milk.

Human milk contains about 6 per cent., and cow's milk about 4.5 per cent., of milk-sugar.

Malt-Sugar. It is also called *maltose*. It is obtained by the action of malt on starch. Malt contains a ferment called *diastase* which changes starch into malt-sugar. When barley-grains are allowed to germinate, diastase is produced in them. The germinated grain is called *malt*.

When crushed grains (containing starch) are steeped in water, mixed with an extract of malt and heated to a temperature of 60 to 65 degrees, the starch becomes converted first into *dextrin* and then into maltose. The liquid is evaporated to a syrupy consistency and extracted with 90 per cent. of alcohol in which maltose dissolves.

Maltose is a crystalline substance soluble in water. It is changed into grape-sugar when boiled with diluted acids. It throws down a red precipitate when boiled with Fehling's solution.

Large quantities of spirituous liquor are manufactured from maltose by fermentation. Nearly all beer and whisky are made from maltose.

STARCH. It occurs in nearly all parts of plants, in seeds or grains (rice, barley, wheat, maize, millet, etc.), in rhizomes, tubers and roots (potato, arrowroot, *sathi*, cassava etc.) and in fruits (unripe plantains). It is largely used as food. It is also used for sizing and stiffening cloths, for laundry purposes, as well as for the manufacture of dextrin, invert sugar and alcohol.

It is generally manufactured from rice, potato or maize (Indian corn). The substance is softened in water, crushed and then washed with water. The water carries with it fine starch-grains. The milky liquid is allowed to stand, when the starch-grains settle at the bottom of the vessel. It is then de-watered by a centrifugal machine and dried.

It is a soft, white, substance insoluble in water. Arrowroot is practically pure starch. Starch grains of different food-stuffs such as wheat, barley, rice, potato, arrowroot, etc., are of different shapes and sizes, some ovoid, some round, some angular, some elliptical, but they all exhibit a striated appearance with a *hilum* under the microscope. They could be distinguished from one another by a microscopic examination only.

When heated in water, the granules burst, the contents of the cells (granulose) dissolve in the water and form a slightly opaque solution, known as starch-paste which, when cold, strikes a blue colour with a solution of Iodine. This

is a test employed for detecting both Iodine and starch. The blue colour is discharged on heating the solution but reappears on cooling.

When starch is heated short of turning brown, it is converted into *dextrin*. When it is boiled with dilute acids, it is first converted into *dextrin* and then into *dextrose* (grape-sugar).

DEXTRIN. The methods of preparation of *dextrin* have already been described under starch. It is a white substance soluble in water, turning brown with Iodine. It forms an excellent paste with water and is largely used as such under the name of *British gum*.

Many of the invalid foods are nothing but dextrinised starch. Fried rice in the form of *Moorhi, Khoi* and *Chirha bhaja* is a common light dextrinised Indian food.

CELLULOSE. The last of the carbohydrates with which we are chiefly concerned in this lecture is *cellulose*. It is the chief material for making paper. It is the principal constituent of the cell-membrane of all vegetable cells and may be regarded as the skeleton of all vegetable tissues. It is found in all parts of the plant constituting their fibrous frame-work.

The fibres of plants consist of cellulose mixed with a large number of other organic substances such as *wax, resin, pectin, lignin* etc. In order to obtain pure cellulose from vegetable fibres for making paper, these substances have to be removed by treatment with certain chemicals.

Cotton wool and *unsized* paper (filter paper) may be regarded as practically pure cellulose.

Unlike other members of the same family, cellulose resists the action of most chemicals. It is unaffected by weak acids and alkalies which are, therefore, used to separate cellulose from other extraneous substances which are rendered soluble by these chemicals. This is why the paper-manufacturer boils his raw material with caustic soda or lime.

Cellulose is white, tasteless and insoluble in water. When it is treated with a strong solution of an alkali, the fibres swell up, shrink lengthwise and become transparent. Cotton fibres, when treated in this way, undergo a similar change, giving a peculiar wrinkled surface on the fibres. Such stuff is known as *mercerised cotton* (from Mercer who first noticed the change).

Strong sulphuric acid dissolves cellulose. If sulphuric acid is diluted with water in the proportion of 2 to 1 and a piece of blotting paper is dipped into it and then quickly removed, thoroughly washed with water and dried, the paper is rendered tough and transparent. Such paper is called *vegetable parchment.*

When cellulose is boiled for a long time with diluted sulphuric acid, it is first converted into dextrin and then into grape sugar. It is, therefore, possible to convert wood into grape sugar and then into alcohol by fermentation.

We have thus in *saw-dust* a very cheap material for the manufacture of alcohol.

Cellulose turns into a jelly-like substance when treated with a solution of black oxide of copper in ammonia in which it is soluble. If a piece of paper is dipped into this solution, a thin jelly-like coating forms on the surface of the paper which, on drying, renders the paper impervious to water. Such paper is called *Willesden paper.*

Cotton wool readily dissolves in an ammoniacal solution of copper oxide and is precipitated as a gelatinous mass by the addition of acids, alcohol or common salt. This jelly-like mass may be drawn into fine fibres which, when dry, form glistening tough threads which go by the name of *artificial silk.*

Cellulose, when treated with a mixture of strong nitric and sulphuric acids, is converted into an explosive substance known as *nitro-cellulose.* Gun-cotton, which is a variety of nitro-cellulose, is obtained by the action of these acids on cotton wool. It is a highly explosive compound used in making cartridges. If cotton wool is treated with this acid mixture for a short time only, certain compounds called the *lower nitrates of cellulose* are formed which, when dissolved in a mixture of alcohol and ether, form the liquid known as *collodion* which is largely used in surgical practice. When applied to superficial wounds, collodion forms a thin

transparent coating on drying which is impermeable to air, thus preventing the access of specific germs to the wound from the air.

Collodion is also used for making artificial silk by mixing it with diluted sulphuric acid and blowing the mixture through fine apertures into cold water when it becomes solidified into fine tough transparent threads like silk-fibres. These are then treated with certain chemicals to destroy their explosive property.

Cordite (smokeless powder) is an explosive substance made from gun cotton by dissolving it in acetone and adding nitro-glycerine to the mixture.

Blasting gelatine is another explosive substance largely used for blasting purposes and is made by dissolving gun-cotton in nitro-glycerine.

Celluloid is a tough elastic material from which a large number of useful articles, such as combs, paper-cutters, handles of knives and umbrellas, toys, catheters, etc. are made. It is manufactured by dissolving the lower nitrates of cellulose in a mixture of acetone and camphor to which a few other substances are also added. It is a semi-transparent, hard, tough, elastic substance which becomes plastic on warming, and in this state can be shaped into any form. It is insoluble in water and is inflammable.

CHAPTER III.

CHEMICALS USED IN THE MANUFACTURE OF PAPER.

We shall now deal with the chemicals used in the manufacture of paper.

The two principal chemicals used for this purpose are (1) *Caustic Soda* and (2) *Bleaching Powder*. The first is used in the preparation of the *pulp* from crude vegetable fibres, and the second for removing the dirty colour of the pulp and making it white, as otherwise no white paper can be obtained.

Instead of caustic soda, a few other chemicals are also used for preparing the pulp. The action is the same in all cases *viz.*, to separate pure cellulose from other organic substances with which it is intimately associated in vegetable fibres. *Lime* is one of the substitutes for caustic soda used in the manufacture of cheaper kinds of paper from jute. In the case of paper made from wood pulp, *sulphurous acid* alone or the *bisulphite of Calcium* or of *Magnesium* is largely used for making the pulp, the last two being obtained by passing sulphur dioxide gas through towers containing *calcined lime* or *magnesia* kept wet by a jet of steam.

CAUSTIC SODA. It is a compound of three elements, *viz.*, Sodium, Hydrogen and Oxygen.

Sodium, like gold, silver, copper, lead, mercury, etc., is a metal but is not found free in Nature. The most widely distributed and the most abundant natural compound of Sodium is sodium chloride or common salt, which is found in enormous quantity in solution in the sea-water, and also as an extensive solid deposit under the earth in many places as in Cheshire, Lancashire and in many parts of India and in beds of rock-salt. It is obtained either from sea-water by evaporation and crystallization, or from the salt-beds by mining operations.

Metallic sodium is now-a-days obtained by passing an electric current through fused caustic soda, which is broken up into Sodium, Oxygen and Hydrogen. It is a soft, bluish-white metal which can be easily cut with a knife. The cut surface rapidly tarnishes by the action of the oxygen of the air with which the metal combines to form an oxide. As the metal has a great attraction for oxygen, it cannot be kept in air, nor under water which it decomposes, liberating hydrogen which, under certain conditions, may take fire and burn with a bright yellow flame due to the presence of vapours of sodium in it. It is, therefore, kept in a liquid called Naphtha which contains no oxygen but only carbon and hydrogen.

Sodium decomposes water combining with the oxygen and forming an oxide of sodium which disolves in water and forms a solution of

caustic soda. This, when evaporated to dryness, leaves a white solid residue which is *caustic soda.*

Caustic soda is generally prepared by boiling a strong solution of carbonate of soda with lime. *Saji mati* which is impure Indian carbonate of soda, may be used for this purpose.

It is now economically manufactured by the electrical decomposition of fused common salt. Sodium is liberated at the negative pole and this, combining with water, forms caustic soda. Chlorine is evolved at the positive pole and the gas is passed through slaked lime for the manufacture of *bleaching powder.*

Caustic soda is a white substance readily soluble in water. It rapidly absorbs moisture and carbonic acid gas from the air. It acts as a caustic when applied to the skin. It has a strong alkaline reaction, turns red litmus paper blue, turmeric paper brown and phenolphthalin solution red.

Caustic soda is largely used for the manufacture of soap and paper; it is also used as a reagent in the laboratory.

Bleaching Powder. The next important chemical used in the manufacture of paper is *bleaching powder.* It destroys the dirty colour of the *pulp* and makes it white. It is composed of three elements, *viz.*, *calcium, chlorine* and *oxygen.* It evolves chlorine gas when acted upon by acids and this chlorine gas destroys vegetable and animal colours.

Bleaching powder is prepared by the action of chlorine gas on slaked lime. The *bleaching* action of the bleaching powder is due to chlorine gas. We may, therefore, briefly consider here the properties of this gas.

Chlorine is a gaseous element. It is ordinarily prepared by heating together a mixture of Manganese dioxide (a black mineral known as *pyrolusite*) and strong Hydrochloric acid. It is a greenish-yellow gas having a diasgreeable suffocating odour. When inhaled in an undiluted condition, it produces severe spasm and inflammation of the air-passages and may cause death. It is heavier than air and somewhat soluble in water, this solution known as chlorine water is used as a reagent in the laboratory. As it does not keep long, it should be made fresh when required.

Chlorine has a strong affinity for some of the other elements with which it combines with great energy, even at the ordinary temperature. Phosphorus and antimony when brought into contact with this gas, unite with it with such great energy that they take fire and burn in the gas.

Chlorine has got a very strong attraction for hydrogen. A mixture of these two gases in equal proportion explodes with great violence when brought into contact with an electric spark or a flame, or even in the presence of direct sun-light. Even when hydrogen is in combination with other elements, chlorine has

the power to wrench it away and unite with it to form hydrochloric acid. A solution of chlorine in water, therefore, becomes dilute hydrochloric acid after a few days. If turpentine, a coumpound of hydrogen and carbon, is brought into contact with this gas, the hydrogen of the turpentine combines with chlorine to form white fumes of hydrochloric acid gas and the carbon separates out in the form of black particles. The action is so violent that heat and light are produced in this reaction. This strong attraction of chlorine for hydrogen explains its *bleaching* and *disinfecting* action for which it is so largely used.

When any vegetable or animal colour moistened with water, is brought into contact with chlorine gas, it combines with the hydrogen of the water forming hydrochloric acid and liberates oxygen which unites with the colouring matter and oxidises it, changing it into a colourless compound. This is how chlorine acts as a *bleaching agent*. The presence of water is necessary; a perfectly dry colour is not bleached by chlorine. If a red *Jaba* flower (Hibiscus) is moistened with water and then placed in a jar of chlorine gas, the flower will be whitened within a short time.

Chlorine can not bleach mineral colouring matter. If a piece of paper bearing printed matter and also writings with the ordinary blue-black ink be moistened with water and introduced into a bottle containing chlorine

gas, it will be found that while the writings in blue-black ink (a vegetable colour) altogether disappear, the matter in printing ink (a mineral colour) remains intact.

In a similar manner, chlorine acts as a disinfectant. The germs of infectious diseases are killed by chlorine by a process of oxidation. It is, therefore, used as a disinfectant, generally in the form of bleaching powder.

For disinfecting a sick-room, a piece of cloth moistened with a solution of bleaching powder is hung on the door or window of the room on the windward side. The bleaching powder is slowly decomposed by the carbonic acid gas of the air and chlorine is evolved which purifies the air of the room.

For rapidly disinfecting a room, a quantity of bleaching powder is put on a china plate placed on a hot brick in the centre of the room, the doors and windows of which are closed. Dilute hydrochloric acid is then added to the contents of the plate when chlorine is rapidly evolved and it kills the germs present in the room.

Bleaching powder is used for purifying drinking water, specially in Field operations and in times of out-breaks of water-borne epidemic diseases.

Chlorine also acts as a *deodorant* i.e., a destroyer of bad smell. Offensive smell produced by putrefying animal substances is at once removed by chlorine. For this purpose, it

is best generated by the action of strong hydrochloric acid on chlorate of potash placed in an earthen cup when a yellow gas (a mixture of chlorine and oxide of chlorine) is immediately evolved, which at once destroys the bad odour.

Bleaching Powder is of a dull white colour obtained by passing chlorine through slaked lime. It possesses a peculiar smell. When acted upon by diluted acids, it gives off chlorine gas which bleaches vegetable and animal colours. If a piece of Turkey-red or indigo-dyed cloth be placed in a mixture of bleaching powder and water in a test-glass and then acted upon by dilute hydrochloric acid, the cloth is bleached (rendered colourless) within a short time.

Bleaching powder is largely used in calico-printing, i.e., for producing white patterns on coloured cloth. The pattern is imprinted on coloured cloth by means of a thick paste called the '*discharge*'. It is then dipped into a mixture of bleaching powder and water. Chlorine is evolved at those places only which contain the prints of the acid *discharge*. The colour is, therefore, bleached at these places only, which thus appear as white patterns on the coloured ground.

LIME. It is also called *quick lime*. It is an oxide of the metal called *Calcium*. It is produced when metallic calcium burns in the air.

It is obtained on a commercial scale by burning *limestone* or any other natural carbonate of lime, such as chalk, shells of sea-animals &c., in specially constructed kilns when carbonic acid gas escapes into the air and *lime* is left behind in white hard lumps.

Lime is a white caustic substance which combines with water with great energy forming *slaked-lime*. So much heat is produced in this reaction that steam is given off and the hard lumps of *quick-lime* crumble into a soft white powder.

Lime is slightly soluble in water and the solution is alkaline in reaction. This solution is called *lime-water* which is used as a medicine, and also as a reagent in the laboratory for testing carbonic acid gas which turns it milky.

Slaked lime slowly absorbs carbonic acid gas from the air and sets into a hard mass. It, therefore, enters largely into the composition of mortars for building purposes.

Lime is used in agriculture to destroy excess of organic matter in the soil. It is also used for the purification of drinking water from which it removes the *temporary hardness*.

Lime is one of the few substances which is infusible even at the high temperature of the oxy-hydrogen blow-pipe flame. If a cylinder of lime be impinged upon by a jet of the oxy-hydrogen blow-pipe flame, the particles of lime become white-hot and emit a dazzling bright white light which could be seen from a long

distance. This is *lime-light* which at one time was used for signalling purposes.

A few other chemicals which are used for the *loading* and *sizing* of paper will be briefly described in their proper places.

CHAPTER IV.

MANUFACTURING PROCESS.

The various kinds of raw materials used in the manufacturing of paper have been placed under the following four heads:—

(a) *Rag fibres* obtained from cotton and linen rags.

(b) *Cellulose fibres* obtained from different kinds of grass, straw and wood by chemical treatment.

(c) *Woody fibres* obtained from wood by mechanical treatment only. This is generally known as *mechanical wood-pulp*.

(d) *Waste-paper*.

Of all the above materials, rags produce the best kind of paper. The most durable and high class paper is obtained from linen rags and the next best comes from cotton rags.

Rags constituted the principal raw material for paper until 1860, when Thomas Routledge introduced into England esparto grass (which grows abundantly in Spain and Africa) as a substitute for rags, and this is now extensively used in Europe for the manufacture of paper of good quality. In India, *sabai* and *moonj* grasses are now largely used for paper-making in place of rags. The different kinds of grass yield about 46 per cent. of pulp.

Paper of good quality is also obtained from straw but the percentage of pulp is less than what is yielded by esparto grass.

There are two kinds of pulp obtained from wood. One is called the *chemical wood-pulp* which consists of cellulose obtained by boiling wood-fibres with caustic soda or other chemicals. The other kind of pulp is called the *mechanical wood-pulp* which is only pulverised wood without its having been subjected to any chemical treatment. The paper made from this kind of pulp is generally of very poor quality; it easily breaks on folding and is very susceptible to atmospheric action. Only the cheap kinds of paper are made from it.

There are three principal stages in the manufacture of paper, whether made by hand or machine. Whatever be the nature of the raw material used, the processes are practically the same, with this difference that in the boiling process, the kind and quantity of the chemical used, the period of boiling and the atmospheric pressure under which the boiling is done, vary with the kind of raw material used. This will be noticed in its proper place.

The first stage in the manufacturing process is the "*preparation of the fibre*". The raw material is sorted, cut and mechanically cleaned of all adventitious matter found associated with it. Then the *chemical operation* begins which consists of boiling the raw material with certain chemicals, followed by *washing, breaking,*

bleaching and neutralising the boiled stuff.

The second stage consists in further *beating* the bleached stuff, *loading* it with certain mineral substances and *sizing* and *colouring* it, previous to its being thrown on the mould and turned into a sheet of paper. We can appropriately call this stage as the "*preparation of the paper-material*".

The third stage is devoted to the conversion of the *prepared paper-material* into a finished sheet of paper ready for use either for writing or printing. The different processes involved in this stage are *moulding, pressing, drying, calendering smoothing and glazing and cutting or reeling* the finished web of paper. We may call this stage as "*the finishing of paper.*"

The several processes are arranged below in the order in which I propose to take them up for consideration :—

(1) Sorting.
(2) Cutting.
(3) Dusting.
(4) Boiling.
(5) Washing and breaking.
(6) Bleaching.
(7) Beating.
(8) Loading.
(9) Sizing.
(10) Colouring.
(11) Moulding.
(12) Pressing.
(13) Drying.
(14) Calendering.
(15) Cutting or Reeling.

SORTING. For paper made from rags, these are first subjected to the process of *sorting* by which rags made of cotton, wool, silk &c. are separated and placed in different receptacles to be used later on in the manufacture of different kinds of paper. This is done by hand and women are generally employed for the purpose. Buttons, rings, hooks and other fixtures are carefully removed from rags, and old sails, ropes, pieces of canvas, if present, are also separated.

Sorting is necessary as the fibres of cotton, hemp, jute, wool, silk &c. are not of equal strength and they all cannot be bleached by one and the same process. Hence the necessity for separating them and using each or a suitable mixture for a particular kind of paper.

There are itinerant female hawkers in Bengal known as *Basanwalis* who procure old and rejected clothings from private houses by exchange of useful household goods, such as metal utensils &c. Some poor women and children make their living by picking up rags from the rubbish thrown in the streets of large cities. These ultimately find their way to paper-mills as an important raw material for paper. There are traders who deal in old clothes and a neighbour of the writer (now dead) amassed a large fortune by supplying rags, first to the Serampore paper-mill, and afterwards when this mill ceased to exist, by exporting rags to America.

In the case of grass, the roots and weeds are removed by hand, but now-a-days, the cleaning is done by machinery.

Wood-pulp is made from a certain variety of pine and aspen. The wood is cut into small blocks and crushed in the direction of the length of the fibres by placing them between two revolving heavy stone-rollers. The fine pulp is separated and washed away from the coarser fragments by a stream of water flowing continually in the grinding machine.

CUTTING.—The next process employed in the case of rags, straw &c. is *cutting*. This is generally done by a machine called the *cutter* which is provided with knives which cut the material into the required size. The cutting process to a certain extent also helps the removal of dirt and dust by constant agitation of the material within the machine. The superior kind of *bank note paper* and *drawing paper* is made from linen rags which are cut by hand. The rags are placed on a table the top of which is made of wire-cloth which allows the dust to pass through. The table is provided with a strong knife fixed in a slanting position by which the rags are cut.

DUSTING:—The next process is that of *dusting*. By it, the sand and other kinds of dirt sticking to the material are mechanically got rid of. The apparatus used for this purpose is called the "willow" or "devil". It consists of a

conical drum to which are fixed several rows of strong spikes. The drum revolves in a case which is also provided with rows of spikes at the top. The rags falling between the rows of spikes are violently agitated and thus the dirt and dust sticking to their surface are mechanically removed. The lower part of the case is in the form of a perforated grating to allow the dirt to pass through. A hopper is attached to the apparatus for feeding it with raw material and there are doors for the discharge of the cleaned contents.

From the *willow*, the material goes into the "*duster*" which is a hollow cylinder made of iron bars encased in wire-netting. The cylinder is made to revolve; the rags remain within the machine but the dirt comes out through the wire-netting.

In the *grass-duster*, the cylinder is stationary. There is a revolving drum (square-shaped) with four rows of spikes fixed to it. The cylinder has got only one row of spike at the top.

The *sorting*, *cleaning* and *dusting* operations are generally done in the upper storey and the cleaned material passes through a trap-door over an endless felt into boilers which are stationed on the ground-floor of the factory.

BOILING.—The cleaned material is now subjected to the process of *boiling*. It is put into the boiler with the necessary chemical, varying in nature and strength according to the

kind of raw material used. In the case of rags, straw and grass, a solution of caustic soda is used. For rags, sixteen pounds of a sixty per-cent solution of caustic soda is used for every cwt. of the material. For grass and straw, a larger quantity of caustic alkali is used. For brown and rough paper made from jute waste, *milk of lime* instead of caustic soda is used. For preparing chemical wood-pulp, the pulvarised wood is boiled either with caustic soda or with a solution of sulphurous acid or bisulphite of calcium or magnesium.

For boiling rags and straw, revolving boilers are used. They are generally spherical in shape and provided with pipes for admission of steam, by which the boiling is done. There is an outlet for the discharge of the spent alkali. The material and the alkali solution are put into the boiler through an air-tight iron door and the boiling is effected by steam under an atmospheric pressure varying from 10 to 40 lbs. per square inch according to the nature of the material used. The boiling is allowed to go on from 5 to 8 hours. There is another air-tight door at the lower part of the apparatus through which the boiled material is removed. There is a pressure-gauge and a safety-valve attached to the boiler.

Boiling of rags is now done by an improved and more economical method in an apparatus known as the *Mather Steamer Kier*. The rags are packed in waggons fitted with perforated

bottoms which are next introduced into a horizontal cylindrical vessel called the *Kier*. Caustic soda solution is introduced by means of pipes and made to circulate through the rags by means of centrifugal pumps. In this apparatus, boiling is done by exposing the rags (continuously wetted with caustic soda solution) to the action of steam at an atmospheric pressure of 10 lbs. per square inch.

For boiling grass, a stationary boiler is used to prevent the grass from becoming matted together and thus not being thoroughly acted upon by the alkali. The boiler is provided with a false perforated bottom on which the grass rests. Steam is introduced by a pipe which opens at the top of the boiler. It goes down to the bottom and causes the alkali solution lying there to come up through the outer-pipe, raise the hood attached to its top and fall on the grass in the form of a spray. The spent liquid is drawn out by means of a tap fixed to the bottom of the boiler. The capacity of the boiler is such that about 45 maunds of grass could at one time be boiled in it. There is a door for the introduction of the material and another for taking out the stuff. Partial washing of the boiled stuff is done with cold water in the boiler before it is removed.

The object of boiling with an alkali is to soften the material and remove all fat, oil, wax, gums, resinous and colouring matters which are always found associated with vege-

table fibres. These substances are mostly insoluble in water but they form soap when boiled with an alkali. All soaps are soluble in water; hence these impurities are readily removed by boiling with an alakali and washing with water.

The used-up alkali solution still contains a certain quantity of caustic soda which is recovered by suitable methods.

WASHING AND BREAKING.—After the boiling has been finished, the softened and chemically cleaned material is subjected to the process of *washing and breaking.* These processes are carried on together in a single machine called the *washing and breaking machine.* The boiled material is introduced into this machine and repeatedly washed with clean water to remove all traces of the alkali; at the same time, it is also broken up into small shreds. The apparatus consists of a rectangular vessel with rounded ends fitted with rollers to which clusters of steel knife-blades are fixed which, in their revolution, close upon similar knife-blades fixed at the bottom of the apparatus. The material coming under the rollers are acted upon by both sets of blades and are thus cut and torn into shreds. The distance between the two sets of knife-blades may be increased or diminished according to requirement by means of an adjusting wheel. Clean water is allowed to constantly flow into the apparatus by means of a pipe opening at its bottom. The dirty water is removed by a *drum-washer* made of wire-gauze

which remains partially submerged in the contents of the apparatus. The wire-gauze allows the dirty water to pass into the drum washer but the meshes are too fine to allow the washed material to pass through. There is a set of revolving buckets within the drum-washer by which the dirty water is raised and emptied into its cone-like central part by which it is carried into a trough and discharged outside. There is a series of such apparatus and the pulp flows from one to the other where the same process is continued by which it is thoroughly washed and beaten at one and the same time. It is now ready for the bleaching process. The *washing* and the *breaking* processes generally take about two hours for completion.

The pulpy material thus obtained is called *half-stuff*.

BLEACHING.—The drum-washer is next taken off the *washing* and *breaking machine* and a solution of bleaching powder (calcium hypochlorite) in water varying in strength according to the nature of the raw material used is added to the *half-stuff*. The knives of the roll are allowed to act on the pulp by which it is thoroughly mixed with the bleaching powder. The action of the bleaching powder is hastened by heat. Acids are generally avoided. The improved method of bleaching now employed in many factories is by the electrolysis of magnesium chloride when magnesium hypo-

chlorite is formed which acts more effectually than calcium hypochlorite as a bleaching agent.

Instead of bleaching being done in the *breaking machine*, another apparatus called the *potcher*, is used for the purpose. It is provided with blades which are blunt and which act as paddles and cause the pulp to circulate and get thoroughly mixed with the bleaching agent.

The stuff is then allowed to run into a series of tanks provided with perforated bottoms where it is allowed to rest for some time and then thoroughly washed with clean water to remove the excess of bleaching powder.

BEATING.—The bleached stuff is next removed to a *beating machine* of similar construction as the *breaking machine*, only the blades are larger in number and are more rapidly moved, so that the pulp is further torn and broken into smaller and finer shreds of about one to two millimeters in length. This is necessary as the length of the fibres in the case of all raw materials is not the same. When beaten in this machine, the fibres are reduced to a uniform size and this is essential for the proper felting of the fibres which gives strength to the paper.

NEUTRALISING.—Any trace of bleaching powder left in the washed pulp is removed in the *beating machine* by the addition of certain chemicals called the *antichlor*. Sodium sulphite or hyposulphite is used for this purpose.

This is then thoroughly washed with clean water, the "*beating machine*" having a similar arrangement for washing the stuff as the *washing and breaking machine.*

LOADING.—The stuff is now mixed with certain white mineral substances which serve to fill up the pores of the paper, make it whiter and give it a better surface. When added to excess, they increase the weight of the paper and are then regarded as adulterants. *China clay* and precipitated *sulphates of lime* and *baryta* are generally used as *loading* materials. They are thoroughly mixed with the pulp in the *beating machine.*

SIZING.—The next process is that of *sizing* which makes the paper incapable of soaking and spreading ink. Without *sizing*, the paper acts like blotting paper and is useless for writing and printing purposes. For most machine-made printing papers and for some writing papers also, the *sizing* material is *resinate of aluminium*. First of all, resinate of soda is prepared by boiling a solution of carbonate of soda with resin. This is mixed with the pulp in the *beating machine* to which an excess of a solution of alum is added. Resinate of aluminium is precipitated in a fine state of division and mixes thoroughly with the pulp. Such sizing goes by the name of *Engine-sizing*. Some starch, either in the form of powder or paste is also added which helps to bind the fibres together more intimately, although it has very

little *sizing* action. Soap is also used along with starch for sizing purposes.

For hand-made paper and for better class machine-made writing paper, a solution of gelatine with alum is used for *sizing*. The *sizing* solution is placed in a tub and each sheet of paper is separately dipped into it two or three times and allowed to dry by being hung on a rope made of cow's hair. Such *sizing* is called "*Tub-sizing*". Many varieties of machine-made paper are subjected to "*tub-sizing*" after they have received *engine-sizing*.

COLOURING.—The stuff, however well-bleached, retains a faint yellow colour. This must be neutralised and the colour made white. This is done by adding to the pulp a little blue pigment which being complementary to yellow, turns it into white. Experience has shown that the addition of a little red colour with the blue makes the stuff perfectly white. For blue, *ultramarine* or *smalt* or *aniline blue* is used, and for red, a solution of *cochineal red* is employed.

For making coloured paper, pigments of various kinds, such as *prussian blue, chrome yellow, venetian red* and *aniline colours*, are largely employed.

This concludes the second stage of the manufacture of paper, viz., "*the preparation of the paper-material*". It is now ready for being thrown on the mould.

MOULDING.—The prepared stuff next flows into a store-vessel called the *stuff-chest*, in the

case of machine-made paper, or into a vat in the case of hand-made paper. Here it is mixed with water to the required consistency. The *stuff-chest* is provided with a vertical revolving shaft armed with wooden paddles which keep the pulp and water in constant agitation, thus helping to maintain a uniform mixture of the two and preventing precipitation of the former.

The stuff-chest is cylindrical in shape and can hold from 1000 to 1200 lbs. of the mixture of pulp and water. This mixture is made to flow over the mould by means of a pump, after running through *strainers* which serve to remove all particles of sand and imperfectly beaten fibres that may still be present in the pulp.

The *paper-machine* consists of a *wire-cloth mould* connected with a series of appliances for *pressing*, *drying* and *calendering* the continuous sheet of paper formed on the mould. The wire-cloth mould is endless and travelling; it is carried by a number of rolls and is kept stretched at the two extremities. There are 40 to 80 meshes per square inch in the wire-cloth. It receives a side to side movement as it travels onwards which helps the distribution of the fibres of the pulp not only in longitudinal but also in other directions as well, and this ensures the strength of the paper. The fibres settle on the cloth in a thin layer and the excess of water passes through the meshes.

The pulp travels in company with the wire-cloth for about 6 yards only. By this

time, it forms a thin sheet which now leaves the *mould* and passes between the felt-covered metallic cylinders of the *couch rolls* by which it is pressed and partially dried.

The flow of the pulp on the mould is regulated and the thickness of the sheet determined by a brass plate called the *slice* which is fixed over the upper surface of the mould in such a way that there is a space between the wire-cloth and the slice through which the pulp flows and this can be increased or decreased according to the thickness of the paper to be made.

The width of the paper is regulated by means of two India rubber bands called the *deckle straps*. These are also endless and lie on the wire-cloth lengthwise near its two borders and travel with it. They form a kind of raised borders on the wire-cloth in its longitudinal direction and are placed there to regulate the width of the paper. The space between them can be narrowed or widened according to requirement.

Underneath the front portion of the wire-cloth mould are two *vacuum boxes* connected with air-pump which serve to draw away water from the thin moist sheet of paper formed on the mould.

There is another box beneath the mould which receives the drained water mixed with a certain amount of pulp which is used again to wet the pulp.

On certain papers, *water-lines* and different kinds of writings and designs which are translucent are to be seen. These are called *water-marks* and are made on the sheet of paper while on the mould and still wet, by pressure with light rollers called the *dandy rolls*. The designs are made of raised wires on the surface of the rolls. When lightly pressed on the moist sheet of paper, the fibres at the pressed points are thinned which on drying show water-marks.

COUCH-ROLLS : The delicate sheet of paper as it leaves the wire-cloth mould passes between the two cylinders of the couch-roll which are made of iron cased in brass and covered with felt. These compress, consolidate and partially dry the sheet when it passes between them. Being still very delicate, it is carried forward on an endless felt which serves as its support.

PRESS-ROLLS :—The sheet next passes through press-rolls which consist of metal cylinders. In this apparatus, the sheet of paper is subjected to further pressure and acquires a little finish.

DRYING CYLINDERS :—After leaving the *press-rolls*, the sheet of paper, bereft of its felt support, passes over a series of cylinders which are made of iron and kept hot by circulation of steam within them. There is graduated heat in these *drying cylinders*, the last cylinder being the hottest of the lot. Sixteen or more such cylinders are employed for drying the sheet of

paper which travels over one after another until it is completely dried.

SMOOTHING ROLLS :—The *drying cylinders* are usually arranged in two sets, and between these is placed a set of highly polished rolls through which the sheet of paper is made to pass and which serve to smooth down its surface. These rolls are called *smoothers.*

CALENDERING :—The thoroughly dry sheet of paper, after leaving the last *drying* cylinder, passes through a stack of highly polished heavy iron rolls arranged in a vertical line. The sheet of paper threads through the stack from the top to the bottom or from the bottom to the top and receives its *finish*, i.e., becomes perfectly smooth and glazed.

REELING :—The continuous sheet of finished paper known as the *web*, is now wound up in reels. It is afterwards cut by a machine into the required width and re-reeled. The smaller reels are subsequently cut into sheets of required length, counted and bound up in reams, each containing 480 sheets which are made compact by putting them under a press.

PAPERS OF DIFFERENT SIZES :—There are various kinds of paper used for printing and writing having different sizes. For example, the size of the *demy* paper is $15\frac{1}{2}'' \times 20''$; of the *foolscap*, $13\frac{1}{2}'' \times 20''$; the *double foolscap*, $27'' \times 27''$; the *royal*, $20'' \times 25''$; the *crown*, $20'' \times 15''$ and that of the *double crown* $20'' \times 30''$.

HAND-MADE PAPER:—The difference between *machine* and *hand-made* papers consists chiefly in (1) that the sheets of hand-made paper are made singly; (2) that hand-made paper is always subjected to tub-sizing, and (3) that hand-made paper is allowed to dry naturally at a comparatively low temperature.

The mixture of pulp and water of the required consistency is placed in a vat instead of into a *stuff-chest*. The mould for hand-made paper consists of a wooden frame (varying with the size of the paper to be made) having a bottom made of wire and provided with a *deckle* placed at all the four borders to regulate the length and width of the sheet. The mould with the *deckle* forms a kind of wire-cloth tray which is dipped into the mixture contained in the vat and the required quantity of the pulp is taken up, any excess being returned to the vat. A vigorous shake is now given to the frame from before backwards and from side to side which helps the proper distribution of the fibres on the wire-bottom of the mould. A thin sheet of paper is thus formed, the excess of water draining away through the messes.

The *deckle* is now removed and the mould with the wet sheet is made over to an assistant who turns the mould over a piece of felt on which the sheet of paper drops. He makes a pile of these, each sheet of paper alternating with a sheet of felt. This pile is next put under a press (about 100 lb. pressure). A great part

of moisture is thus removed and the sheets are consolidated.

The partially dried sheets are next separated from the pieces of felt, re-arranged in the form of a pile and subjected to pressure again in the press. By repeating this treatment two or three times, the felt-marks on the sheet of paper are removed, most of the moisture got rid of and a better surface secured.

The sheets are then dried in air in a room at a temperature of about 80°F. by suspending them over ropes made of cow's hair which leaves no stain on the sheets. The dried sheets are next subjected to *tub-sizing.* They are individually immersed in a solution of *gelatine, alum and starch* placed in a tub, which may be repeated two or three times. The sheets are then dried in air as before, pressed, sorted and reamed.

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The History and Chemistry of Matches.*

CHAPTER I.

(1) *Production of fire before matches came into use.*

Before the invention of matches, fire was produced by *friction* or *percussion* between two hard combustible or incombustible bodies.

In the days of the Vedas, fire was necessary for the performance of all sacrificial rites. It was usually produced by friction between two pieces of dry wood. The pointed end of a dry wooden pole was introduced into a hole made in a block of dry wood and caused to rotate. Sufficient heat was thus generated by friction to cause the pole to smoulder.

It was the custom with the ancient Aryans to keep fire perpetually burning in their places of worship. The custom is extant among the Parsees, who, it is said, brought their *holy fire* from Persia at the time of their settlement in

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Western India in the 7th or 8th century A.D. The same fire is said to be still burning in their temple at Bombay.

It is said that the early Christians also kept lights perpetually burning in their churches.

Greek mythology tells us that it was Prometheus who first brought fire into the earth by stealing it from the abode of the gods. Some oriental scholars have suggested that the Greek name Prometheus has its origin in the Sanskrit word *Pramanthan* which means the production of fire by the friction of two pieces of wood as practised in the Vedic times. The Greeks knew how to produce fire by focussing sun's rays by concave metallic mirrors. We read in history of the destruction by fire of a Roman fleet before Syracuse by the focussed rays of the sun brought about by concave mirrors.

From very early times, the Egyptians knew how to produce fire which they required for metallurgical operations and the manufacture of pottery. Representations of these industrial operations and furnaces are still to be seen engraved on monuments in Egypt whose origin dates back to about 5000 years.

It was a common knowledge that sparks could be produced by percussion between two pieces of stone or between pieces of stone and iron and this had been the universal practice of producing fire both in India and in Europe before matches came into use. This method

is still practised in India in remote villages. The time-honoured *tinder-box* of Europe held its sway until 1820 or 1825 A.D. when it was gradually replaced by matches. In India, a piece of dry pith (*sola*) was used to catch the spark and the fire was transferred to a piece of jute-stick previously tipped with melted sulphur. A flame was thus obtained from which all lights and fire for domestic purposes and for smoking could be had. One of the chief household duties of our grand-mothers and great grand-mothers was to prepare these sulphur-tipped jute-sticks. In those days, owing to the difficulty of quickly obtaining fire, specially during the night, people used to keep smouldering rice-husk in earthern pots which caused a sulphur-tipped jute-stick to inflame when plunged into it. It was a slow and feeble fire but would not readily go out.

Fire-syringes were invented by means of which fire could be instantaneously produced but these were hardly suitable for general use. In the fire-syringe, a flash is produced by the sudden compression of the air in the closed cylinder in which is placed some inflammable material such as a piece of tinder which thus catches fire and burns.

These physical methods of production of fire were gradually replaced by chemical methods and Dobernier's lamp is an ingenious application of the latter method. In it, there is an arrangement for the generation of Hydrogen

gas by the action of some dilute acid on granulated zinc. The jet of Hydrogen issuing from the apparatus is made to impinge upon spongy platinum which induces its oxidation and causes it to burn. Such an arrangement, however, is only suited for laboratory purposes.

(2) *Invention of Matches.*

The production of fire by chemical methods gradually improved both in simplicity and in economy, until the culminating point was reached by the invention of matches.

OXYMURIATE MATCHES.—These were the first chemical matches made in Paris by Chancel in 1805. They were tipped with a mixture of chlorate of potash, sugar and gum ; they ignited when dipped in strong sulphuric acid.

CONGREVES.—The first *friction matches* were made by an Englishman, John Walker, in 1827 ; these were called "Congreves" after Sir William Congreve. The tips of these matches were made of chlorate of potash and sulphide of antimony ; they ignited when rubbed against a piece of sand-paper fixed to the box. One shilling was charged for a box of 84 matches.

VESTAS.—These are matches with *wax-tapers* forming the match-stems. The tip-composition is the same as that of the oxymuriate matches and it ignites on coming into contact with a piece of folded sand-paper so placed

in the metal case as to get rubbed against the head of the vesta at the moment of its withdrawal. Although the patent was taken by Newton, an Englishman, these were first manufactured in France in 1836. Since then, much modification in the composition of the stem has been introduced by various manufacturers. A mixture of wax and paraffin or strips of Bristol boards impregnated with resin, stearin &c., have from time to time replaced the pure wax in the stems of the vestas. They are not much in use now, but some may still be seen offered for sale.

FUSEES.—These are cigar-lighters made of brown paper or card-board soaked in a solution of nitrate of potash, the igniting composition usually containing phosphorus. They are known in the trade by various significant names such as *Vessuvians, Etnas, fixed stars, braided lights &c.* and consist of a *stem* made of glass, wire or wood, a *head* or *ball* of "pastille" composition, and a *tip* of igniting composition. In the *braided light* manufactured by Bryant and May, the igniting composition is retained in position by a piece of thin wire over which strands of cotton are twisted by the braiding machine.

Other kinds of chemical matches such as *repeating* or *continuous matches*, and special kinds of cigar-lighting appliances have from time to time been made but they have never come into general use.

LUCIFER MATCHES. These matches containing yellow phosphorus in the tip was first manufactured in Austria in 1833. The igniting composition was a mixture of yellow phosphorus and chlorate of potash which readily ignited when rubbed against any rough surface. These were in universal use for more than half a century until they were replaced by the *safety matches*. Although much improvement had been effected in the igniting composition of the lucifer matches, there were some grave objections to their manufacture and use. One of these was their ready inflammability on slight friction or pressure which led to many serious accidents. Another objection was in respect of the highly poisonous character of the yellow phosphorus. It was found that workmen in *lucifer match* factories used to suffer severely from a disease of the lower jaw-bone brought on by inhalation of the fumes of yellow phosphorus used in the manufacture of these matches. All these inconveniences and dangers have been done away with by the introduction of the harmless variety of phosphorus, known as the *red* or *amorphous phosphorus* which is now used in the manufacture of *safety-matches*. In many countries, such as Denmark, Switzerland &c., the manufacture of *lucifer* matches, on account of their dangerous character, has been prohibited by law.

SAFETY-MATCHES.—In the manufacture of safety-matches, yellow phosphorus is not used;

The tips are made of a mixture of chlorate of potash and sulphide of antimony and the dark brown *rubber* on the sides of the match-box contains the non-inflammable (*red*) variety of phosphorus. These matches do not ignite by ordinary friction but do so only when rubbed against the specially-prepared paper fixed to the sides of the box. Hence they are called "safety-matches". By the use of these, all dangers attending the manufacture and use of *lucifer matches* have been avoided.

CHAPTER II.

Chemicals used in the manufacture of matches.

For the manufacture of matches, *lucifer* or *safety*, two kinds of chemicals are needed.

One of these acts as a burning material, and the other helps it to burn. The former is called a *combustible* or *inflammable* or *oxidisable* substance, and the latter is called the *supporter of combustion* or *oxidising* substance. The familiar illustration of a burning candle will make the meaning quite clear. Here the substance of the candle consisting of Hydrogen and Carbon is the combustible or burning material. The supporter of combustion in this case is the Oxygen of the air. If there had been no oxygen in the air, the candle inspite of its being an inflammable substance, would not burn. These two kinds of substance, the *combustible* and the *supporter of combustion* must be associated together to cause the phenomenon of burning. We shall see that both these are present in the igniting *composition* of matches.

The most important chemicals used in the manufacture of different kinds of matches are—(1) *Phosphorus* in one or other form; (2) *Chlorate of Potash* and (3) *Sulphide of Antimony*. There are a few other chemicals such as manganese dioxide, nitrate of potash, red lead,

bichromate of potash, thiosulphate of lead &c., which are used either as associates of or substitutes for one or other of the above three principal ingredients. *Glue* is used to bind up the materials in the tip of the match, and *glass powder* or *sand* is used to favour friction. Besides these, some *colouring matters* are used to colour the tips of certain kinds of matches. We shall confine our attention to the three principal ingredients of matches viz., *Phosphorus*, *Chlorate of Potash* and *Sulphide of Antimony.*

PHOSPHORUS.—It is an element but it does not occur free in nature. The elementary Phosphorus is found in two different forms, the *yellow* and the *red* variety. Chemically they are the same, but physically, they differ widely from one another in their properties.

The *Yellow* or as it is called the *ordinary* Phosphorus was discovered by Brand of Hamburg in 1669 A.D. It is found in nature united with two other elements, viz., *Calcium* and *Oxygen* in a compound called the *phosphate of lime*, which occurs as a vast mineral deposit, and also as the principal constituent of the bones of animals.

For about 100 years after its discovery, no body knew to what use it could be put. In fact, it was looked upon as a chemical curiosity.

Yellow phosphorus is manufactured from *bone-ash*. Bones are burnt and the ash consisting almost wholly of *phosphate of lime*, is treated with strong sulphuric acid when phos-

phoric acid is set free and remains in solution. The solution is mixed with coarsely powdered charcoal and heated to dull redness in cast iron retorts. The charred mixture is then distilled in clay retorts at bright red heat when vapours of phosphorus are evolved ; these are condensed, melted, strained, purified and allowed to flow through cold glass tubes, when phosphorus solidifies in the form of rods which are taken out and cut into fragments of the required length.

Phosphorus is now prepared from bone-ash by mixing it with carbon and heating this mixture in an electric furnace. Phosphorus distills over and carbide of calcium remains in the furnace.

The other variety of Phosphorus is called the *red* or *amorphous* phosphorus. It was discovered by Schroder in 1854. It is prepared by heating the yellow phosphorus to a temperature of 240°C. in closed vessels in an atmosphere of nitrogen or carbon dioxide which has no chemical action on phosphorus.

It may also be prepared by heating *yellow* phosphorus to 260°C. in contact with Iodine.

Yellow phosphorus is always kept under water, as it gets rapidly oxidised and may take fire if kept exposed to air. No such precaution is necessary in the case of red phosphorus.

The two kinds of Phosphorus vary widely in their properties as will be seen from the table in the next page :—

TABLE I.

Variety.	Colour.	Consistency.	Odour.	Behaviour on exposure to air.	Sp: gravity.	Solubility in carbon di-sulphide	Other properties.
Yellow Phosphorus	Pale yellowish.	Soft. waxlike, crystalline.	Strong, garlic-like.	Luminous in the dark ; gives off white fumes, combines with the oxygen of the air and may inflame spontaneously.	1.83	Soluble	Very poisonous
Red Phosphorus	Red-coloured	Powdery, amorphous.	Nil.	Non-lumious ; does not fume : does not burn unless heated to a temperature of 260°C.	2.14	Insoluble .	Non-poisonous.

Yellow phosphorus readily combines with certain elements such as oxygen, chlorine, bromine, iodine &c., at the ordinary temperature, sometimes with such energy as to produce heat and light. Thus yellow phosphorus, when placed in a bottle of chlorine gas or when brought into contact with a drop of bromine or a crystal of iodine, takes fire and burns with the formation of the salts of those elements.

Phosphorus is insoluble in water. As it can not be kept exposed to air, it is always kept under water and should always be cut under water, as the friction with the knife during cutting may produce sufficient heat to inflame it. It should be handled with great care.

The solution of yellow phosphorus in carbon disulphide is a thin colourless liquid. When exposed to air, the carbon disulphide being volatile, rapidly evaporates, leaving the phosphorus in a fine state of division. This being rapidly oxidised by the air, takes fire. This solution goes by the name of *Greek fire*; when thrown upon combustible substances such as a piece of cloth or paper, it sets it to fire after a short time.

Phosphorus dissolves in oil and this solution appears luminous in the dark. Articles smeared with this phosphorated oil shine and are visible in a dark room.

When yellow phosphorus is boiled with caustic potash or soda, it combines with hydrogen and forms an offensive-smelling gas

called *phosphuretted hydrogen*, the peculiar property of which, is to undergo spontaneous combustion when brought into contact with air. As each bubble of the gas escapes into the air, it burns with a bright flame and forms a beautiful wreath of white smoke which floats in the air and these follow one another in rapid succession.

People dealing with *yellow* phosphorus in the manufacture of lucifer matches, used to suffer severely from a kind of bone-disease affecting the lower jaw. Better hygienic conditions of the factories and improved methods of manufacture have greatly minimised the evil. The disease has practically disappeared since the introduction of the non-poisonous variety of phosphorus (*red*) in the manufacture of safety matches.

Chlorate of Potash.—It is made of three elementary substances viz., *Oxygen*, *Chlorine* and *Potassium*. We have already considered Oxygen and Chlorine in one of our previous lectures.

The metal *Potassium* is a soft silvery-white substance which readily combines with oxygen. Even when oxygen is in combination with hydrogen (as in water), it takes away the element from water with great energy, producing heat and light. It can not, therefore, be kept either exposed to air or under water, but is kept in fluids, such as naphtha &c., which contains carbon and hydrogen only but no oxygen.

The physical and chemical properties of Potassium are very nearly the same as those of Sodium. These have already been described under *Paper-making* and need not be described here.

Chlorate of Potash is prepared by passing Chlorine gas into a solution of caustic Potash when two salts,, potassium chloride and potassium chlorate are formed ; the latter being less soluble, separates out in white tabular crystals.

It is a highly oxidising agent. When a combustible substance such as sulphur, sulphides of antimony or arsenic &c., is mixed with it and subjected to friction or percussion, the mixture explodes with great violence attended with a loud report. When such a mixture is set fire to, it burns with great energy. When sprinkled over burning coal or charcoal, chlorate of potash sets up violent combustion.

When heated alone, it breaks up into oxygen gas and potassium chloride. This substance is used for obtaining oxygen for experimental purposes in the laboratory. When mixed with a small quantity of *manganese dioxide* and heated, it gives off oxygen at a much lower temperature and much more readily and such a mixture is largely used in the laboratory for the preparation of oxygen.

A mixture of chlorate of potash and sulphide of antimony or of arsenic is used for the manufacture of ordinary crackers which explode.

with a loud report when violently thrown over the ground or struck against any hard surface. Many serious accidents have occurred in attempting to powder together chlorate of potash and sulphides of arsenic or antimony in the preparation of fireworks or bombs. The two should be powdered separately and then mixed together gently by means of a spatula.

When chlorate of potash is acted upon by strong sulphuric acid, it is decomposed and a yellow gas is evolved which is a highly *oxidising* agent and explodes violently on the application of heat. Care should be taken in preparing this gas in the laboratory; it should be made in small quantities only. This yellow gas is known as *chlorine peroxide* and it sets fire to combustible substances when brought into contact with them. For example, if fragments of yellow phosphorus and crystals of chlorate of potash are placed under water in a glass vessel and a small quantity of strong sulphuric acid is poured into it, the fragments of phosphorus will take fire by the oxidising action of *chlorine peroxide* evolved by the action of sulphuric acid on the chlorate of Potash and continue to burn under water. Similarly, if a mixture is made of chlorate of potash and sugar and touched with a drop of strong sulphuric acid, a violent action will ensue and the mixture will burn with a sudden and bright flash.

Chlorate of potash is largely used in the manufacture of coloured fires. These are mix-

tures of chlorate of potash and sulphur to which certain metallic oxides or salts are added to produce the required colour. For example, the *red fire* composition contains nitrate of strontium; the *green fire*, barium nitrate or chlorate, and the *blue fire*, black oxide of copper in varying proportions. These produce red, green and blue lights respectively.

A mixture of chlorate of potash, sulphur and yellow prussiate of potash forms what is known as the *white gun powder* which easily explodes by friction or percussion.

ANTIMONY SULPHIDE.—It is the next important ingredient used in the manufacture of matches. It is a compound of antimony and sulphur and is ordinarily known as *black antimony* which is the chief ore of the metal. Its Indian name is *surma* which is used as a medicine for certain eye-affections in indigenous practice. It occurs in heavy black shining crystalline brittle masses. It is a combustible substance and forms an explosive mixture with chlorate of potash. Such a mixture forms the composition of the tip of *safety* matches. The tip of a *safety* match does not ignite by friction against any ordinary rough surface but only when rubbed against the prepared paper attached to the side of its box, by virtue of its containing *red phosphorus* in contact with which the mixture becomes very sensitive.

CHAPTER III.

Process of Manufacture.

In giving a description of the manufacture of matches, the arrangement adopted in Thorpe's Applied Chemistry has been followed, supplemented by information from personal inspection of factories and plants.

The four principal operations involved in the manufacture of matches, *lucifer* or *safety*, are :—

(1) Splint-cutting.
(2) Dipping.
(3) Drying.
(4) Boxing.

There are several minor operations involved in the process which will also be briefly described.

WOOD FOR MATCH-SPLINT.—The splints are generally made of some kinds of *pine* wood. In England, the white Canadian pine wood is almost exclusively used for this purpose. In Sweden, *aspen* is most commonly used. Other varieties of wood, such as *poplar*, *birch*, *beech*, *willow*, *deal*, *cedar*, *linden* &c., are also used in other continental countries.

There ought to be no difficulty in getting good wood for matches in India. Various kinds of *pine* tree grow abundantly in the Himalayas,

and other trees yielding the proper kind of wood for matches also grow in other parts of India. Labour is cheap but the heavy cost of transport is a great draw-back.

SCURFING.—In English factories, planks about 12 ft. in length, 3 inches thick and 11 inches wide are first *smoothed*. This process, known as *scurfing*, is done by machinery.

CROSS-CUTTING.—The smoothed planks are then cut by a machine into blocks usually 4¾ inches long which are equal to twice the length of English match-splints.

STEAMING.—If the wood is too dry, it must be exposed to steam for a short time.

SPLINT-CUTTING.—The blocks are then introduced into a splint-cutting machine of which there are many forms. The kind of machine mostly used in English factories is known as the *flaking* machine which is provided with a vertical slicing knife by which the blocks of wood are first cut into flakes of the required thickness and then turned into splints double the length of a match-stick. These are then passed on to a table from which they are collected and removed for further operations. One of these machines can turn out 17 millions match-splints in a day.

There is another kind of machine called the *toothing* machine which works well with soft pine wood. The machine is provided with cutters consisting of vertical lancet-points or

teeth, which score or groove the surface of the blocks to a depth equal to the thickness of a match and the grooved portions are then sliced off by a horizontal knife and fall as match-splints.

In Sweden, Germany and in Japan, splints are made from round blocks of wood which are made to revolve on a turning lathe and a continuous thin band of wood of the thickness of a match is cut off from the revolving block by a fixed knife. This broad band of wood at the same time is divided lengthwise by several vertical knives into smaller bands, each of a width equal to the length of a match. These smaller bands are next fed into a machine in which they are traversely cut into splints by a guillotin knife. These machines are sometimes worked by hand but more often by steam-power. When worked by hand, they can turn out 5 millions splints per day and double this quantity when the machine is worked by steam-power.

Drying the cut splint.—The next operation is that of *drying* the cut splints, For this purpose, the splints are usuallly loosely spread over a large tray and dried by exposure to warm dry air. In Sweden, the splints are put into wire-gauze cylinders which are made to revolve inside a stove.

Sifting.—After drying, the splints are *sifted* in a kind of sieve by which process, all fragments and splinters are removed

DIPPING.—The next process is known as the *dipping* process in which the ends of the splints are coated with the igniting composition. In the earlier days, the operation was generally done by hand; the splints either collected into bundles of convenient thickness, or arranged on dipping boards and the ends were first put into melted sulphur and then into the *igniting mixture* kept in a shallow vessel. This has been replaced by what is now known as the *frame* or *clamp dipping*. The apparatus used for this purpose consists of sixty movable boards placed one over the other and secured in square frames with sides made of iron rods. Each board has sixty-five grooves on its upper surface, each groove accommodating a double-length match-splint which is held in position by the pressure of the felt with which the lower surface of the board is lined. One such frame holds 3900 splints. These are dipped at both ends and cut in the middle, thus making 7800 matches. Three to four thousand frames can be dipped in a day by a single workman.

Various improvements have been effected in the machinery used for *dipping* and the "frame or clamp dipping" just described has in many places been substituted by what is known as "*coil or band dipping*" in which the splints are placed between the coils of a long tape of cotton-webbing, about the thickness of a match-splint and of a shorter width than its length, wound round a drum. The splints are thus placed

round a drum between the coils of the tape with their two ends projecting beyond the coil which can be conveniently dipped into the igniting composition and allowed to dry in the coil.

After the splints have been arranged in the *clamp* or in the *coil*, they are subjected to the process of *paraffining* or *first dipping* in which the projecting ends are first heated by bringing them into contact with a hot iron plate and then dipped into a melted mixture of *paraffin* and *stearin* contained in a shallow double-bottomed iron tank kept hot by steam. The object of first coating the splints with paraffin is to ensure the ready inflammability of the splints. *Sulphur* was originally used for this purpose, but it has now been replaced in all good matches by paraffin or a mixture of paraffin and stearin.

To provide against accidental fire caused by the dropping of glowing match-splints, precaution is taken to impregnate the stems with solutions of certain mineral salts, such as *sodium phosphate*, *alum*, *sodium tungstate* &c., which causes the splints to cool and cease to glow immediately the flame is extinguished.

IGNITING COMPOSITION.—The paraffined splints are next dipped into the *igniting composition* which varies a great deal with different manufacturers. As has already been described, it contains (1) one or more oxygen-giving substances, (2) one or more combustible substances, (3) some cementing or binding material,

(4) some rough inert substance to increase friction and often (5) some colouring matter.

LUCIFER MATCHES.—In the *lucifer matches* of English manufacture, the *oxygen-giving* agent is *chlorate of potash* either used alone or mixed with manganese dioxide. In the continental matches, *nitrate of potash, nitrate of lead, red lead, potassium bichromate* &c. are used either with chlorate of potash or as a substitute for it. The *combustible* substance in all good lucifer matches is *yellow phosphorus*. The cementing material is usually glue, but gum or dextrine is sometimes used in place of glue. The *rough inert* substance is either sand or powdered glass. Various substances are used to colour the tips of lucifer matches. The colouring matters usually employed for this purpose are prussian blue, ultramarine, magenta, vermillion, smalt, chrome yellow &c. The tips of *safety matches* are as a rule not coloured artificially.

The following is considered to be one of the best *igniting compositions* for *lucifer* matches :—

Yellow Phosphorus ..	3 parts
Chlorate of Potash ..	3 ,,
Glue	3.5 ,,
Water	3 ,,
Sand	2 ,,
Prussian blue ..	0.1 to 0.5 ,,

RUBBER FOR LUCIFER MATCHES.—The composition of rubbers for these matches is made

of a mixture of sand or glass powder and glue or gum, spread on both sides of the match-box. These matches can, however, be ignited when rubbed against any rough surface.

SAFETY MATCHES.—In the case of *safety matches*, the process of manufacture is the same, except that the *igniting composition* and the *rubber* are different from those used in the case of *lucifer* matches. In these, yellow phosphorus is substituted by *antimony sulphide* in the *igniting composition*, and *red phosphorus* is used for the preparation of the *rubber* spread over the sides of the match-box. The mixture of chlorate of potash and antimony sulphide in the *igniting composition* of the safety matches is not sufficiently sensitive to be ignited by any ordinary friction but it inflames at once when rubbed against the *red phosphorus* which forms the coating of the *rubbers* on the sides of the box. Various modifications as regards the nature and proportion of the oxidising and combustible substances in the *igniting composition* have been introduced by different manufacturers. The *composition* used by Landstorm, the first manufacturer of safety-matches, which has been patented by Bryant and May, the celebrated *match manufacturers of* England, is given below :—

A. *Igniting composition*—

Antimony sulphide	..	2-3 parts
Chlorate of Potash	..	6 ,,
Glue ..	..	1 part

B. *Rubber*—

Red phosphorus	..	10 parts
Antimony sulphide or Manganese dioxide.	..	8 ,,
Glue	..	3-6 ,,

RUBBER FOR SAFETY MATCHES.—The red phosphorus and antimony sulphide are mixed with glue to the required consistency and this is spread over the sides of the match-box.

The operation of *dipping* is done in a separate room called the "dipping room". The ingredients are made into an emulsion and spread to the required depth over the dipping table which consists of a shallow flat-topped iron-box into which steam can be admitted to keep it hot. The paraffined ends of the splints held in the *clamp* or *coil*, are plunged into the emulsion and these are placed on racks with the dipped ends downwards in order that the tips may take a good rounded form, after which the other ends of the splints are dipped and similarly treated.

The *dipping* is usually done by hand, but machinery has also been used for coating the splints with the *igniting composition*.

DRYING.—The prepared splints are next subjected to the process of *drying*. For this purpose, the double-tipped splints in *clamps* or *coils* are supported on racks either in the open air when the weather permits it, or in drying

rooms kept warm and dry by steam or by hot air carried round the room in pipes.

LAYING OUT, HALVING and BOXING.—The dried splints are next taken out by hand from the *clamps* or *coils* and laid out for the purpose of cutting them into halves, which is technically known as *halving* or *cross-cutting*. This is usually effected by a lever-cutting knife. The cut matches are finally put into boxes by hand, although machines have also been introduced even to *box* the matches.

MATCH-BOXES.—These are also made of pine wood and are turned out by machine. Ribbon-like slices of wood of the required thickness and width are first made and these are then scored along the lines in which they must be bent into the box-form. Sometimes, moulds are used for preparing the boxes.

The folding of the slices into boxes, covering the boxes with paper, labelling and coating the sides of the boxes with the *rubber composition* and filling the boxes with finished matches are done by hand.

END OF VOLUME I.